ELECTRICAL REVIEW

FRIDAY
22 MAY 1959

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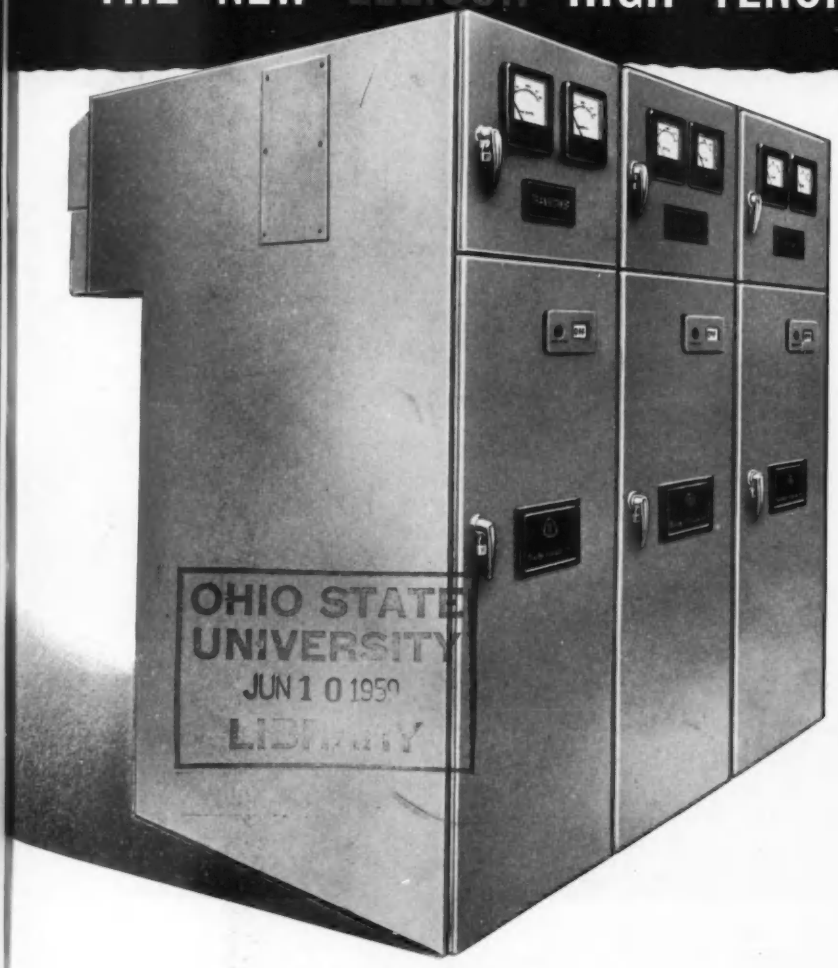

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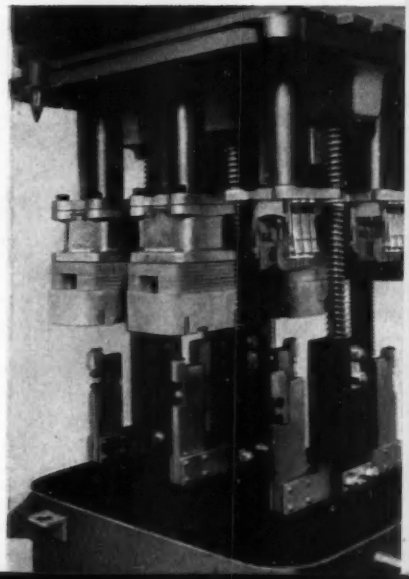

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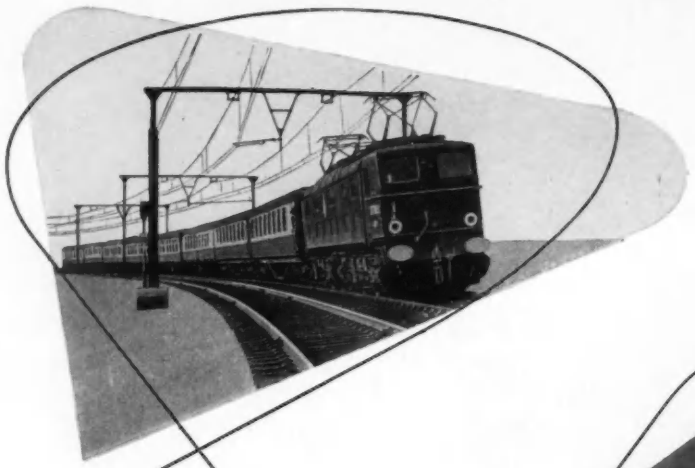

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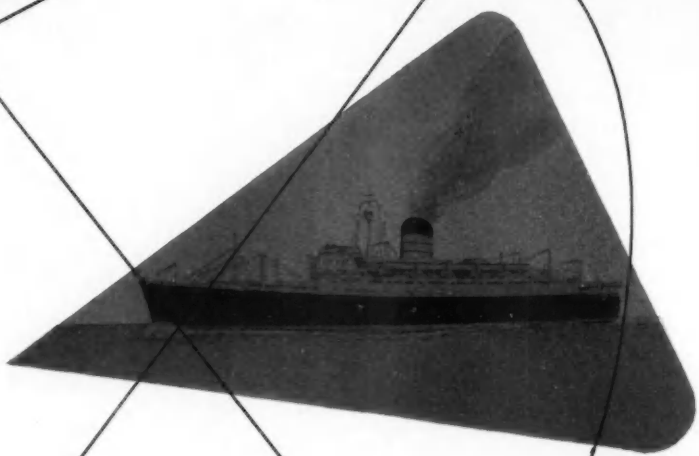

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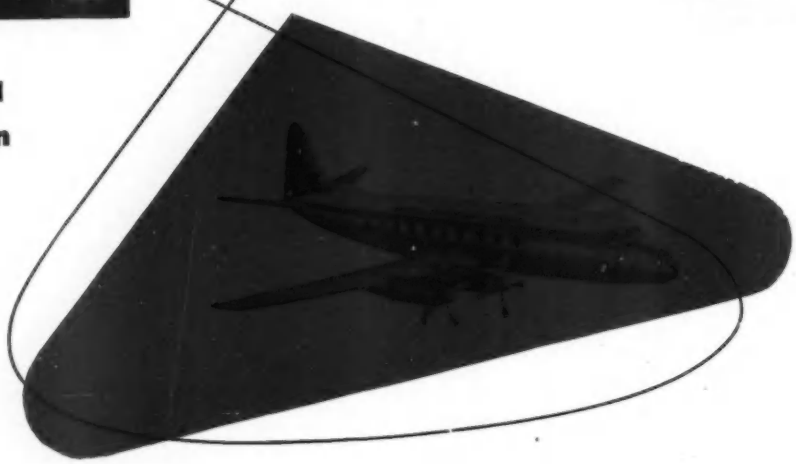

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ELECTRICAL REVIEW

22 May 1959 Vol. 164 No. 21 Established 1872

Transport of Energy

COMPARISONS between the cost of transmitting potential power as electricity or as raw fuel can be drawn only on the broadest lines in view of the very wide variations in local conditions. A general principle is that the higher the voltage, the greater the load and the load factor and the longer the distance, the stronger becomes the case for electrical transmission as against rail haulage. Half the coal burned at the power stations of the Central Electricity Generating Board is carried by the railways and a growing proportion, already over one-third, comes from the developing East Midlands coalfields, the nearest part of which is 120 miles from London.

Until recent years laborious calculations could have produced a more or less useful comparison based on operational schedules, but today conditions are altering so rapidly that the relevant factors would no doubt be beyond the powers even of electronic computers to assess future prospects either quantitatively or qualitatively. There is, for instance, the effect of the supergrid with the possibility of raising the voltage of some sections from 275 kV to 380 kV. Then account has to be taken of technical improvements on the railways, such as full electrification with power from the grid and the diesel-electric system. On the other hand, the transport of small coal used for power stations would be considerably decreased since the C.E.G.B. is the largest single purchaser of coal produced in this country, of which it takes more than one-fifth for the generation of all but a relatively insignificant amount of the kWh sent out from its power stations. By far the greater proportion of the total coal mined in Britain, including large high-grade and special varieties needed for other industries would of course still have to be carried by rail.

The question arises as to how far the economics in working consequent on railway electrification would, through lower freight charges on lighter manufactured goods, offset the present trend towards diverting some of this traffic to improved main roads. In the past the general policy of " charging what the traffic will bear " has generally resulted in such goods making a higher proportionate contribution to the railways' overhead costs than the heavier freights, including coal, which would presumably have to make good any revenue deficiency thus incurred. A new and uncertain factor will be a modification of the pattern of generation due to the situation of nuclear power stations near the coast, which would tend to lower the load

factor of electricity transmitted from coal-fired stations. A counteracting feature is that the works costs (of which coal forms about 80 per cent) of East Midland stations now amount to over 50 per cent more than those of the London Division stations. This appears to leave a large margin in favour of the transport of energy as electricity rather than as coal.

SEMICONDUCTORS

In many applications, thermionic valves have been replaced by semiconductor valves. The word transistor, however, refers to a semiconductor device with at least two junctions which can be used for amplification. Semiconductor diodes are in fact rectifiers, not transistors. Since the invention of the transistor ten years ago, there have been three clear stages of development. The first was the point contact transistor but, due to difficulties of manufacture, it did not come to fruition. The second stage was the design and development of the junction transistor, while the third and present stage consists of the development of the diffused or alloy-diffused type structure. In each case the semiconductor material, either germanium or silicon, has to be formed into a single crystal before it can be used in a transistor.

At the International Transistor Exhibition which is being held at Earls Court until next Wednesday, the various stages of manufacture of a transistor can be seen as well as its innumerable applications. A survey of the exhibition appears on page 938 and a report of the convention, which is being held concurrently, will be published later.

AUTOMOBILE FUSES

The subject of adequate fusing of the electrical system in a private motor car is arousing interest again with the introduction of the Triumph "Herald." No fuses are incorporated in this new car, presumably from economic considerations. However, most modern cars are equipped with only two fuses and these do not protect every piece of equipment. Most of the lighting, for instance, is unfused since it has been thought that a single fuse for the lighting circuit could cause a dangerous situation if all lights were to be extinguished while travelling at speed. If fuses were to be fitted to individual lights, the main cables to the lighting would be unprotected. With the two-fuse system, one fuse protects the equipment which is energised through the ignition switch and the other fuse protects those auxiliaries connected directly to the battery. The stop lights are, of course, protected since they are operated through the ignition switch. A leading manufacturer of electrical equipment for motor vehicles has recommended the adoption of this two-fuse protection system, with both fuses rated at 35 A or 50 A, depending on the load.

Statistics have shown that fuses are rarely called upon to operate and, in an unfused system, one of the most vulnerable points is the windscreen wipers. Mechanical friction or stoppages due to snow and ice on the windscreen can cause the motor to overheat. Some wipers are, however, fitted with a thermostat to guard against this contingency and we are informed that a similar device can be fitted to an unprotected wiper unit at a small cost.

Although we do not agree that the two-fuse system gives adequate protection, it is not costly and it is better than nothing. Provision of a simple overload relay and warning light with back-up fuse or miniature circuit-breaker protection may repay consideration.

THE ANOMALOUS TAX

At last week's E.D.A. annual luncheon (see page 947) Mr. Thomas Johnston pointed to the ridiculous situation in which the Government was endeavouring to clear the air and at the same time was levying purchase tax on electrical appliances which were potent instruments in achieving that aim. On the same day the Paymaster General (Mr. R. Maudling) told the House of Commons that the Government could not consider further reductions in the tax, for fiscal reasons. Purchase tax would continue to be a major raiser of revenue for as far ahead as he could clearly see.

This tax was introduced during the war primarily as a means of curbing consumption. That aspect has now been forgotten; otherwise at this particular time the case for its abolition would seem to be overwhelming. But once any form of taxation has been instituted the Exchequer comes to rely on it and attempts to reduce or remove it are not regarded very favourably.

ELECTRICITY ON THE FARM

From reports received from various areas the general impression is gained that farmers are still not making full use of electrical service provided at great expense. That is why we think Lord Waldegrave, Parliamentary Secretary, Ministry of Agriculture, was taking a rather rosy view when he said at the E.D.A. luncheon that the days of the mere 20 W lamp in the cowshed were over and implied that farmers were rapidly becoming all-electric.

In the last C.E.A. report (1957-58) it was said that "rural electrification would show improved economic results if greater use of the service was made by individual farms." It was considered that the rise in the average consumption of farms, from about 5,000 kWh in 1953-54 to nearly 6,400 in 1957-58, did not convey a true picture. The average was swollen by the very large consumption (up to 40,000 kWh a year each) of a few farms, whereas one farm in six used less than 1,000 kWh a year. The great amount of work being put into rural electrification by E.D.A. and the Electricity Boards encourages hope of great improvement in due course.

POWER CONVENTION ISSUE

Next week's "Electrical Review" is the annual British Electrical Power Convention issue. In addition to details of the arrangements for the Convention (Torquay, 1st to 5th June), the issue will contain our biennial tables giving full particulars of the power stations of Great Britain, a preview of the exhibition and special signed articles

Electric Refrigerators

THE CHOICE OF SYSTEMS

By D. C. BILLING, B.Sc.(Eng.), A.C.G.I., A.M.I.Mech.E.*

The article is mainly concerned with a comparison between the vapour compression and absorption systems for domestic refrigerators. Test data, size and price comparisons are given. The summary shows a greater all-round economy and flexibility favouring the compression system against the quietness of the absorption unit

THERE are many known methods of producing a cooling effect. Air-cycle refrigeration systems were developed before modern refrigerants came into use, but the method relies entirely on sensible heat changes. Steam-jet refrigeration is of use in high-temperature water cooling or in distilleries and chemical plants. Centrifugal refrigeration is employed in conjunction with suitable refrigerants—the basic cycle being similar to the vapour compression system but having an impeller in place of the usual pump.

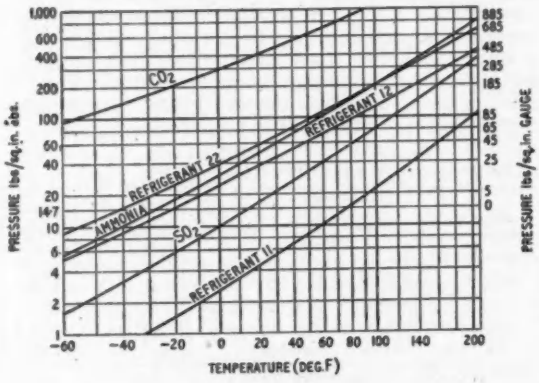
The attainment of very low temperatures may be achieved by evaporating liquefied gases such as air, oxygen or nitrogen. Hydrogen or helium are also used for the lowest temperatures, the latter enabling levels below 1 deg K to be reached (i.e. below −272 deg C). Demagnetisation of materials already cooled by helium evaporation removes heat and enables these latter temperatures to be reached.

Other methods include heat removal by the adsorption effects of various solid materials and the use of the Peltier effect which inter-relates potential differences at bi-metallic junctions with heat changes at these points.

Vapour compression machines, using a variety of working fluids, may be employed either as a single stage or may be compounded to produce lower temperature levels. Their scope includes air conditioning, domestic and commercial refrigerators down to quite low temperatures such as −100 deg F (using say Refrigerant 22) or −150 deg F (using say Refrigerant 13).

Absorption machines also have a wide range of use. They are widely applied to process cooling in chemical plants or wherever steam is available as a heating source. They are used in air-conditioning systems and, of course, in household refrigerators. They are not, however, normally applied to other self-contained commercial products such as ice cream, frozen food or display cabinet units. The Platen-Munters patent is the basis of the commoner absorption units used in household refrigerators over the last 30 years.

Fig. 1.—Pressure/temperature relationships of various refrigerants



Electricity is widely used to operate either the compression or absorption systems although direct mechanical drives are occasionally used with vapour compression systems and gas or oil heaters are widely used with absorption systems (in addition to steam where available). There is often a secondary need for electrical power to provide convenient means of control (switching, protection, interlocking, etc.) of cooling plants or for defrosting.

There is, thus, a choice of methods and, in the particular field of household refrigeration, it involves keen competition between the manufacturers of the compression and absorption machines.

Basic Requirements

To refrigerate a load, whether for low-temperature storage, household food preservation or air conditioning, it is first necessary to make a surface cool. In this way heat is extracted from the load, carried away by a fluid through pipes and thrown away (or occasionally used as in heat pumps).

A fluid, when accepting heat, can do so in only two ways—either by allowing its own temperature to increase or by evaporating from a liquid condition to a vapour. (Hence the use of the term "evaporator.") This latter process is normally used since it affords by far the greater economy and fluids are chosen which boil, while accepting heat from the load, under the most suitable temperatures and pressures. This heat is absorbed without raising the temperature of the fluid—it remains "latent." Thus, at atmospheric pressure, ammonia boils at −28 deg F, dichlorodifluoromethane (now called Refrigerant 12) at −21·6 deg F, monochlorodifluoromethane (now called Refrigerant 22) at −41·4 deg F and trichloromonofluoromethane (Refrigerant 11) at +74·7 deg F. A glance at Fig. 1 will show how these boiling, or vaporisation, temperatures vary with pressure. A refrigerant must evaporate at below the required refrigerator temperature and a suitable corresponding "low side" pressure, at which vaporisation is to occur, is therefore chosen.

To remove the heat from the refrigerant, it is convenient to condense the vapour back to a liquid state. Assuming that one is ultimately losing the heat to the surrounding atmosphere, the condensing refrigerant must be warmer than the environment. The surface of the condenser must, therefore, be kept at a lower tempera-

* Frigidaire Division of General Motors, Ltd.

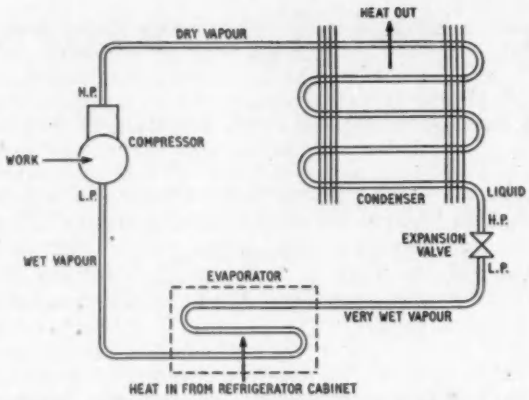


Fig. 2.—Schematic diagram of vapour compression refrigerator

ture than the warm refrigerant by the cooler atmospheric air in household and some commercial systems, or by the cooling water or brine in other systems. Thus at, say, 100 deg F the condensing or "high side" pressure of ammonia is 212·6 p.s.i.a.; that of Refrigerant 12 is 131·9 p.s.i.a.; that of Refrigerant 22 is 212·6; and that of Refrigerant 11 is 23·6 p.s.i.a.

So far the requirements are standard, but the differences come in considering by what means the working fluid can be circulated, in how much effort is spent doing this, and in the comparative success when it does.

Making the Fluid Work

To make the refrigerant work, it must be driven around the circuit. The energy put in must normally be provided by one of the public services and so both gas or electricity are used. Either of these services can provide heat and additionally electricity may be used to operate a motor and drive a pump or "compressor."

There is no simple costing system for the operation of refrigerators as with, say, an electric fire. Different types of refrigerator can give very different returns per kWh in the form of cooling capacity.

In the vapour compression machine the compressor uses the energy provided to lift the refrigerant at one point in its cycle from the low (evaporating) pressure to the high (condensing) pressure. Fig. 2 shows a simple circuit diagram of a vapour compression system. The place of the expansion valve is often taken by a long length of fine bore tubing offering such wall resistance to the flow of refrigerant that its pressure is thereby dropped. Such is the case with the Refrigerant 12 household systems in common use as shown in Fig. 3.

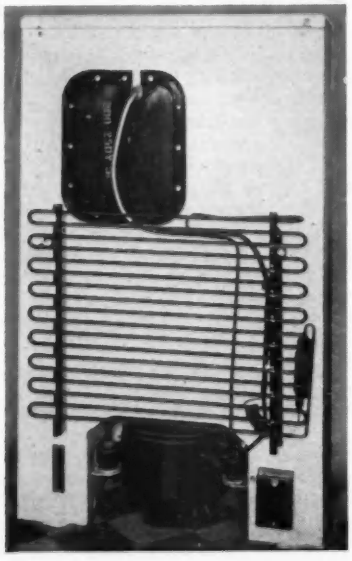


Fig. 3.—Typical vapour compression household refrigerator

In the absorption system the refrigerant, usually ammonia, evaporates in the presence of a light gas, usually hydrogen. The liquid ammonia coming from the condenser is expanded into a hydrogen stream where its evaporating (lower) pressure added to that of the surrounding light gas make a total of the same order as the condensing pressure. Fig. 5 shows a typical system. After passing through the evaporator, the ammonia vapour is absorbed into water from which it is later released to the condenser by a heater. The heater operates as a bubble pump. Power is supplied to the system in the form of heat to the generator. (In larger industrial systems, the liquid seals between high and low sides may be replaced with valves and pumped refrigerant circulation may replace the use of hydrogen.)

Although work is needed to achieve the refrigeration effect, such work is not directly related to the amount of latent heat which the refrigerant accepts in the evaporator whilst fulfilling its chief function. It is quite possible to take 100 B.Th.U. from a food load and spend only 20 B.Th.U. transferring it. Both in the evaporator and in the compressor or heater, energy is being *gained* by the fluid. Thus, the compressor or heater supplies only part of the input. The condenser is the principal place where corresponding energy is *lost* by the fluid. The ratio of the two figures quoted is termed "Coefficient of Performance" and a value as high as 5 is obtainable by the vapour compression system. The word "efficiency" in its usual context does not apply.

Selection of Refrigerant

In practice, the absorption designer generally uses ammonia as his refrigerant. All tubing and components would normally be ferrous and all joints welded. Copper or brass parts would, in any case, be unsuitable due to corrosive attack from the ammonia. Ammonia will evaporate in the presence of a light molecular weight gas and the use of hydrogen is appropriate since no chemical reaction occurs with either ammonia, the solvent, or the plumbing. Water is a convenient solvent having a high affinity for ammonia at low side pressure and temperature and a suitable ability to release the vapour at high pressure when raised to generator temperature. The pressures used on the high side are generally a little greater than in the case of parallel vapour compression systems. Pressures of 200, 250 or even 350 p.s.i.g. are quoted, whereas the latter operate at, say, 140-200 p.s.i.g. As a consequence manufacturers' test pressures, which have to be set above maximum working pressures, are higher in the case of absorption machines.

TABLE I.—PROPERTIES OF VARIOUS REFRIGERANTS

Refrigerant	Sp. Heat of Liquid	Critical Point °F	Freezing Point °F	Boiling Point °F	Theoretical C. of P. at 86°F and 5°F	Net Refrig. Effect(same conditions) B.Th.U/lb	Latent Heat at 5°F B.Th.U/lb
CO_2	0·77	87·8	−69·9*	−109·3†	2·56	55·5	117·6
SO_2	0·34	314·8	−103·9	+14·0	4·87	141·4	169·4
NH_3	1·12	271·4	−107·9	−28·0	4·76	474·4	565·0
Refrig.12	0·23	233·6	−252·0	−21·6	4·70	50·0	68·2
Refrig 22	0·30	204·8	−256·0	−41·4	4·66	69·3	93·6
Refrig.11	0·21	388·4	−168·0	+74·7	5·09	67·5	84·0

* Sublimates. † Not at room pressure.

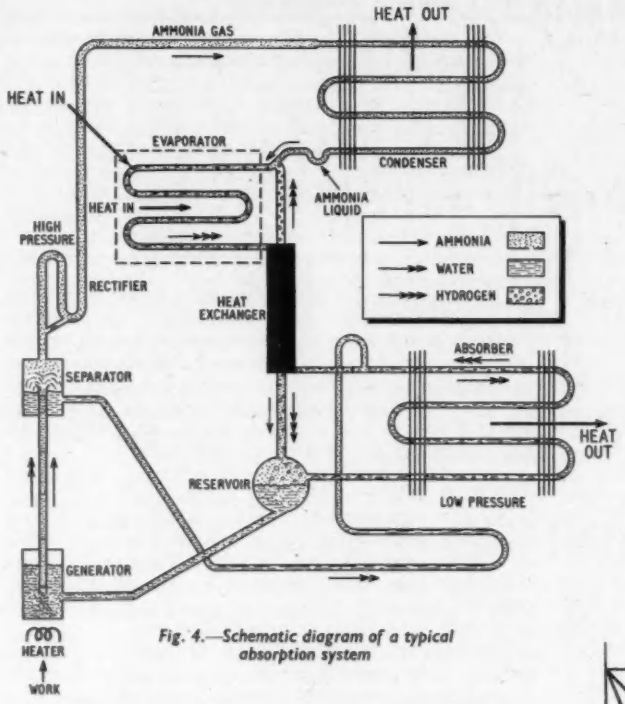


Fig. 4.—Schematic diagram of a typical absorption system

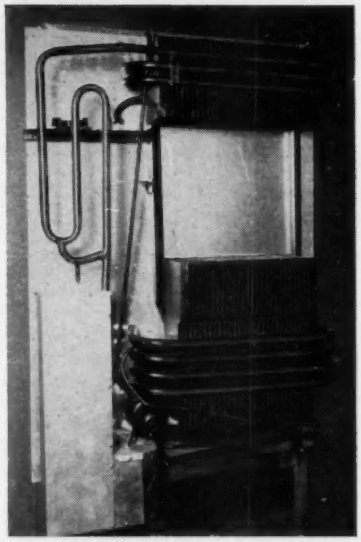


Fig. 5.—Typical household absorption refrigerator

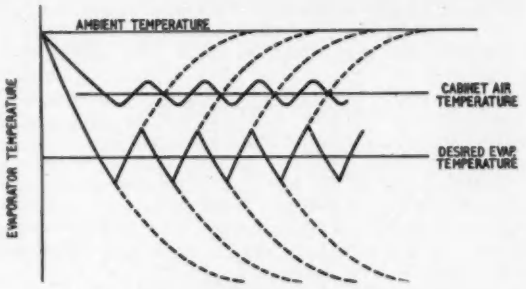


Fig. 6.—Relationship between cabinet air and evaporator temperature

From the evaporator temperature required of a vapour compression machine, it is possible to select a fluid having a suitable low side pressure. Also knowledge of the latent heat, specific heat, specific volume and other physical properties enables the basic design features of the unit to be decided. These essentials are listed in Table 1.

Refrigerant 12 is most commonly used in present times since it has a small positive pressure at most evaporator temperatures, and will achieve the required heat removal without excessively high pressures. It is also non-toxic, practically odourless and non-corrosive to components. Although it has a low latent heat, it has a fairly high density. The result is a good economic proposition and controls do not have to be so sensitive as they would were there more duty per cubic inch of liquid flow.

Other refrigerants can be chosen appropriately to suit, say, low temperature conditions (Refrigerant 22) or perhaps air conditioning (higher evaporation temperatures). Ammonia is also used in certain larger compression systems, mainly due to its low volumetric displacement requirements and the smaller weight needed for a given duty. Economy here outweighs its other disadvantages.

There are a variety of considerations in choosing a suitable refrigerant—latent heat and specific volume properties, power requirements and cost and size of pump to circulate the refrigerant, ideal coefficient of performance under chosen conditions, actual pressure levels in the application, flammability, toxicity and cost.

Other Requirements

The refrigerating machine must reduce the evaporator surface temperature well below the required storage air temperature and it must also be *capable* of reducing the air temperature below the level actually needed and at which the thermostat operates. Although the bulb of the thermostat is usually spaced from the evaporator surface, it operates at a temperature much below that of the main food load.

The amount of heat transferred will differ between empty and full cabinets and a single switch setting must cover a variety of conditions. Also, the ambient temperature can change considerably. Fig. 6 shows the relationship between cabinet air and evaporator temperature. The cooling and warming gradients should not be too steep nor too shallow over the usual operating range.

Further requirements occur in the case of cabinets intended to store frozen foods in addition to normal, somewhat warmer, loads. In certain cases an insulated divider is provided to maintain two-temperature operation and a secondary evaporator of different surface area may even be provided in the higher temperature space.

The relevant British Standards are careful in detailing appropriate tests to assess all these effects. Trials at low ambient temperatures are needed to prove that the main load does not freeze and at higher temperatures to prove that a satisfactory condition is still attained. If frozen foods are to be stored then additional requirements are stated. B.S. 922 gives conditions for service in a maximum of 110 deg F and B.S. 1691 in a maximum of 90 deg F ambient.

The designer can vary a number of features to obtain

TABLE 2.—RESULTS OF TESTS ON FIVE 3-4 cu ft DOMESTIC REFRIGERATORS

Cabinet		Absorption 1		Absorption 2		Compression 1		Compression 2		Compression 3	
Cubic Feet—Interior		3		4		3		3		4	
		Normal switch position	Coldest switch position	Normal switch position	Coldest switch position	Normal switch position	Coldest switch position	Normal switch position	Coldest switch position	Normal switch position	Coldest switch position
50°F Ambient	kWh/24 hr	1·7	3·3	1·1	2·0	0·6	0·7	0·3	0·4	0·7	0·8
	Mean cabinet temp., °F	35	26	43	31	34	30	33	30	33	27
	% running time	50	52	41	70	15	17	11	14	21	27
70°F Ambient	kWh/24 hr	2·3	3·3	2·0	3·0	0·7	0·9	0·5	0·6	0·9	1·1
	Mean cabinet temp., °F	43	30	46	37	40	35	39	36	39	33
	% running time	70	100	67	100	20	25	20	25	27	37
90°F Ambient	kWh/24 hr	3·4	3·4	2·4	3·0	1·2	1·5	1·0	1·1	1·2	1·6
	Mean cabinet temp., °F	52	52	53	47	44	40	44	40	41	36
	% running time	100	100	80	100	31	38	35	44	32	43
Icemaking time at 70°F amb., hr		3½	2½	5½	3	2	1½	2½	2	4½	2½

the best conditions in his machine. The behaviour of a vapour compression machine can be adjusted with a suitable choice of (a) insulation thickness, (b) pressure and restrictor value differential, (c) evaporator surface, (d) condenser surface, (e) pump size, (f) tubing sizes, (g) refrigerant charge, (h) thermostat range and (i) thermostat bulb position.

The absorption machine design can be varied by (a) insulation thickness, (b) evaporator surface, (c) condenser and absorber surface, (d) heater size, (e) tubing sizes, (f) thermostat design, (g) thermostat bulb position and (h) choice of concentration between ammonia and water and the quantities of each required.

Having regard to the flexibility required in operation to meet the needs already discussed, it is basically essential to be able to design a unit (a) which will not be too upset by changes of ambient temperature or of load, (b) in which the thermostat maintains a good average cabinet temperature whilst having a short icemaking time in the evaporator area, (c) which will not be too expensive to run, (d) which will be economical to produce, (e) which will give the biggest food storage space for the smallest external volume and (f) which gives a good service life and causes least inconvenience to the user.

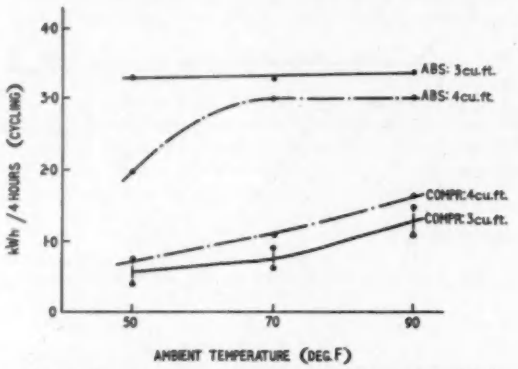


Fig. 7.—Average power consumption (switch on coldest position)

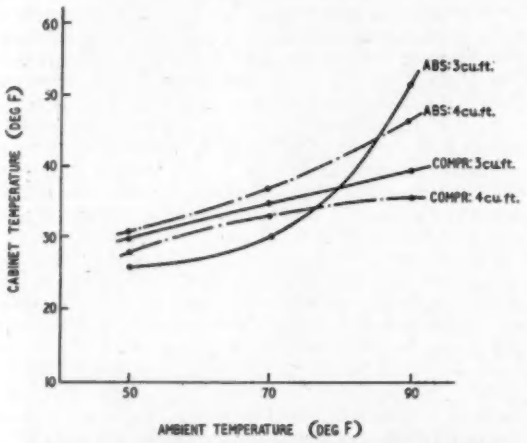


Fig. 8.—Average cabinet temperature (switch on coldest position)

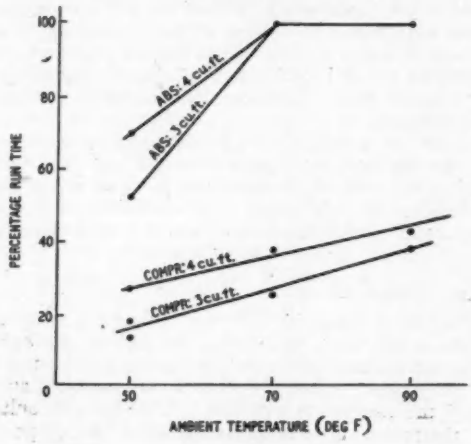
Tests on Typical Products

To give a picture of the characteristics of both types of system, Table 2 has been prepared showing test data against five domestic cabinets, all of the popular 3 to 4 cubic foot size. They represent a range of products of different manufacturing sources, two being absorption units and three being vapour compression.

The features compared are among those mentioned in the last section, namely, cabinet mean temperature, power requirements, percentage running time and icemaking time. The comparisons are made at three ambient temperatures to show the effect of such environment changes. They are also shown at two switch settings (one being the extreme coldest) to demonstrate the amount of correction that it is possible to achieve. Naturally the "coldest" setting gives conditions not usually applied, but it serves better than any other to show the behaviour of the systems on a common basis. On this basis, the graphs shown in Figs. 7, 8 and 9 reveal the comparisons of power requirement, percentage running time and cabinet temperature.

The figures suggest that the designer of the compression machines is more able to meet the flexibility of conditions already discussed than is the designer of absorption units. Whereas in a 70 deg F ambient the

Fig. 9.—Percentage running time in varying ambients (switch on coldest position)



loaded compression machines took, say, ¾ to 1 kWh/day (costing about 1½d), the same loaded conditions applied to the absorption machines required the expenditure of, say, 3 to 3¾ kWh/day (costing about 5d). In addition, the average absorption machine is seen to be less able to cope with higher ambients than the average compression machine, as illustrated by the percentage running times and cabinet temperatures. Further, the icemaking times show a difference of value, again in favour of the compression systems.

On the machines tested, the insulation thicknesses tended to be greater in the absorption machines—a further illustration that there was less capacity available in these particular units, as applied to the cabinets tested.

Other Considerations

The absorption machine has, however, three points which make it distinctive. It can be given its power by any form of heating and coal gas is, of course, common. The same heat requirements as would cost 5d by electricity (3 to 3¾ kWh as used in the above illustration) would cost about 2½d by gas (100,000 B.Th.U per therm at 2s per therm). There is, however, still no balance in the economies and there is the possibility of some nuisance value if the gas should be blown out or be cut off. Various patented control devices are available to defend against explosion hazards.

Secondly, the absorption unit is almost silent. Even here, however, the handicap is being rapidly shortened by several suppliers of vapour compression domestic units who have made considerable improvements in reducing noise levels and now have relatively quiet systems.

Thirdly, the absorption unit is more often applied to units in the very small domestic sizes, 1½ and 2 cu ft, where the duties are so little as to prove rather uneconomic applications of even the smallest compression units yet designed. A user must judge for himself, whether, say, a 2 cu ft refrigerator occupying a kitchen space of perhaps 9 cu ft is worth having against, say, a 3 cu ft compression machine occupying approximately the same space. There are, no doubt, cases where the even smaller cost and external volume of, say, a 1½ cu ft machine are among the most important features; in such cases the present-day absorption unit would be used.

Further analysis of these last questions of space economy and costs are given in Table 3 and the graphs plotted in Fig. 10. This analysis was performed by taking a random check on a number of compression and absorption units and working on published data from the manufacturers. As is to be expected, the smallest units are more expensive per cubic foot and there are more absorption units available in this range. The prices taken are retail figures including purchase tax of 30 per cent. (Since this article was written purchase tax on refrigerators has been reduced to 25 per cent.) It may be seen that the compression machines all fall below the average external/internal volume ratio line and are therefore considerably more economic than the absorption units.

Fig. 10.—Price per cu ft and volume ratio of various sized refrigerators

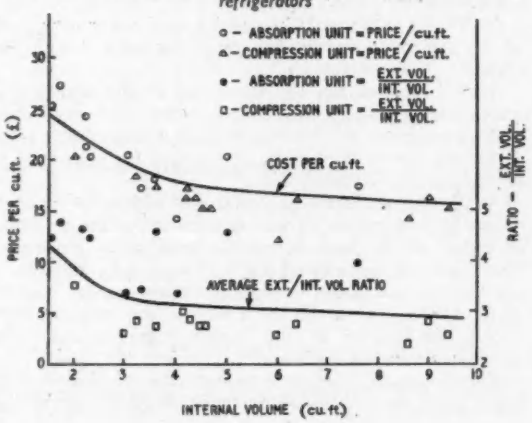

○ – ABSORPTION UNIT = PRICE/cu.ft.
△ – COMPRESSION UNIT = PRICE/cu.ft.
● – ABSORPTION UNIT = EXT. VOL. / INT. VOL.
□ – COMPRESSION UNIT = EXT. VOL. / INT. VOL.
COST PER cu.ft.
AVERAGE EXT./INT. VOL. RATIO
PRICE PER cu.ft. (£)
EXT. VOL. / INT. VOL. RATIO
INTERNAL VOLUME (cu.ft.)

TABLE 3.—PRICE AND VOLUME COMPARISONS (November, 1958)
Prices to nearest £

	Reference No.	Internal Vol. cu ft	Price (Retail) £	External Vol. (approx.) cu ft	Price per internal cu ft £	Ratio Ext. Vol.-Int. Vol.
Absorption Machines	1	1·5	37	6·6	25	4·4
	2	1·7	45	8·0	27	4·7
	3	2·2	46	10·2	21	4·6
	4	2·2	53	10·0	24	4·6
	5	2·3	46	11·0	20	4·4
	6	3·0	59	10·0	20	3·3
	7	3·3	56	13·0	17	3·4
	8	3·6	64	16·3	18	4·5
	9	4·0	57	13·0	14	3·3
	10	5·0	100	22·5	20	4·5
	11	7·6	130	30·0	17	3·9
Compression Machines	1	2·0	39	7·1	20	3·5
	2	3·0	60	7·6	20	2·5
	3	3·2	75	9·0	18	2·8
	4	3·6	59	9·6	17	2·7
	5	4·2	67	12·5	16	3·0
	6	4·2	71	12·5	17	3·0
	7	4·3	68	12·0	16	2·8
	8	4·5	68	12·3	15	2·7
	9	4·6	69	12·5	15	2·7
	10	6·4	101	17·5	16	2·7
	11	6·0	69	15·3	12	2·5
	12	8·6	118	20·0	14	2·3
	13	9·0	145	24·8	16	2·8
	14	9·4	145	24·0	15	2·5

Compression machines are normally driven by induction motors so that speed is constant on a particular supply frequency. An installation in a country district where the terminal voltage was low, would run at the same speed and pump the same gas and hence perform the same duty as a similar installation in a high-voltage area. However, a voltage drop on an absorption system, depending as it does on heat, would cause a variation in duty and the latitude of operation would be reduced.

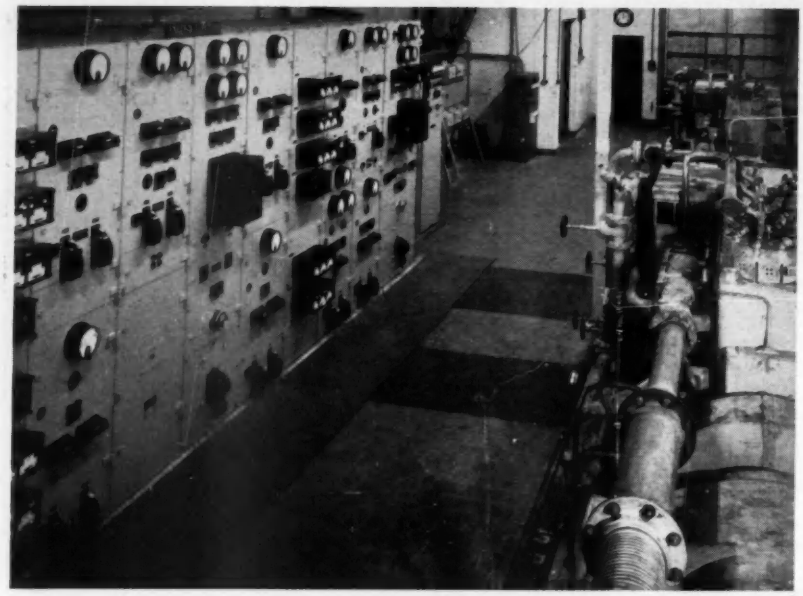
Another serious consideration is the opportunity of carrying out service. It is possible on certain compressor systems to correct a leak and recharge a system or replace a compressor unit or repair a motor. On an absorption unit, servicing is not easy, however occasional it may be, and apart from tipping the unit to re-position the fluids, there is not much a service man can do.

Conclusions

In the domestic field, the analysis of costs, performance and space economy of some typical machines all favour the compression system. The absorption unit may sometimes be preferred for its quietness or perhaps in instances where electricity supply is not available. Apart from these particular considerations, and allowing for the differences mentioned, much depends purely on the choice of a customer in respect of colour, finish and styling. These features play an important part in selling. Nevertheless, the basic aim is usually to preserve food against bacteria action and a temperature of 33-40 deg F should always be maintained.

Iron and Steel Institute

The Iron and Steel Institute is holding a special meeting on the North-East Coast from 6th to 10th July. The programme will include a number of works visits and evening social functions have been arranged for members and their ladies.



Automatic Starting of Diesel Alternators

STANDBY SUPPLIES AT A BIRMINGHAM TELEPHONE EXCHANGE

Two of the three 300 kVA standby diesel alternator sets are equipped for automatic starting if complete or partial mains failure occurs or if a small reduction in system voltage takes place. The automatic system also operates the mains switchgear and loads the alternator when a failure occurs, but mains restoration is carried out manually

WITH the extension of the grid system and the increased generating capacity, the failure of power supplies in Britain due to bulk supply disconnection would appear to be a thing of the past. However, in the event of supply failure, which can be caused by a fault in the distribution system, standby supplies must be provided for certain essential services, such as telecommunication centres. A comprehensive arrangement of standby plant has been installed in the new Birmingham "Anchor" telephone exchange. This exchange was designed to include trunk mechanisation equipment which will ultimately form part of the subscriber trunk dialling system (see *Electrical Review* of 12th December, 1958).

Three 300 kVA diesel alternator sets, two of which are equipped for automatic starting, have been installed. Each set comprises a 400 b.h.p. Crossley HSN3/6o diesel engine driving a 415 V, three-phase, 50 c/s alternator at 600 r.p.m. In each case, a compressed air starter motor, operating at 450 p.s.i. drives the generating set up to full speed in under ten seconds from initiation of the starting sequence.

The starting equipment is in the English Electric 12-panel, double-tier, double-busbar switchboard. The two 800 kVA, 11,000/415 V incoming transformers on the Electricity Board's network are connected to one set of busbars and the three standby sets to the other bars (Fig. 1). The switchboard comprises thirteen 26 MVA, 415 V, type OB3 air circuit-breakers (five incoming circuits, six outgoing circuits and two bus-sections on the standby bars), one busbar isolator on the main bars, three alternator exciter control panels and two main protection panels. Circuit protection is provided by overcurrent and reverse power relays. Carbon pile a.v.r.'s, auto-start relays and engine alarms are mounted on the alternator control panels.

Above: General view of plant room at the "Anchor" telephone exchange, Birmingham

The auxiliary switchboard controlling the essential services can be fed by either of the auto-start alternators or the mains supply (see Fig. 1). Electrical interlocking ensures that both the mains circuit-breakers are tripped before the solenoid-operated alternator circuit-breaker can be closed and Castell key interlocking prevents paralleling of the two auto-start sets through the auxiliary switchboard.

Auto-Start Control

The automatic starting equipment is designed to carry out the following functions:—

(a) To detect mains failure and extend a starting signal to the automatic starting equipment associated with the engine.

(b) To monitor the alternator output and maintain a stable emergency supply.

(c) To transfer the load from mains to standby as soon as the voltage of the alternator selected for auto-start is within prescribed limits.

As the essential services load is well within the capacity of one generating set, provision is made for the selection of either of the two automatic start sets. Normally, No. 1 set will be selected for auto-start duty and No. 3 set will be available for starting under manual control if required. No. 2 set is arranged for manual start should the failure of the mains supply persist and secondary essential loads need to be reinstated.

The automatic starting of the standby diesel alternator takes place on a comparatively small reduction in the

system voltage. The exacting limits specified by the G.P.O. necessitated a three-phase relay which had adjustment over the range of 80-95 per cent of the nominal voltage with a very low pick-up/drop-off differential.

The relay provided is of an electronic pattern which comprises three rectifiers feeding a potentiometer circuit, three valve-energised relays and a neon comparison tube. For single-phase failure, the voltage across the controlled phase is compared with the reference circuit. When the out-of-balance exceeds the pre-set limits the relay operates to initiate the starting sequence. Thus this relay will detect a phase failure or the failing of any two of the line voltages in any combination. Should a complete mains failure occur or the heaters fail or the valves lose emission, the relays will fail safe and initiate a start.

Mode of Operation

Under normal conditions both mains circuit-breakers supplying the auxiliary board are closed and the associated standby circuit-breakers are open. One diesel alternator set is selected for auto-start and the appropriate standby switch on the auxiliary switchboard is closed. The busbar breaker on the standby bar of the main switchboard is open and the automatic voltage regulator change-over switch is set to the auto position.

Having satisfied the above conditions, and provided the engine-starting compressed air system is under pressure, the selector lamp lights up, indicating that all circuit conditions are correct for auto-start and that on mains failure the chosen alternator will be able to run-up and take on load.

Failure of the mains supply will then be detected by the relays previously described. These release if the voltage falls below the setting value. The release of any one phase, or all phases, operates the master control relay, which extinguishes the "mains on" indicating lamps and prepares the circuits for actuation of the engine auto-start equipment. It also prepares the trip circuit for the mains circuit-breaker, which is tripped when the alternator is ready to take over load.

It is essential that both mains feeds to the auxiliary switchboard controlling the auto-start loads shall be disconnected before the selected engine is allowed to take load, to prevent the paralleling of the alternator with the mains via the busbar of the auxiliary switchboard. This

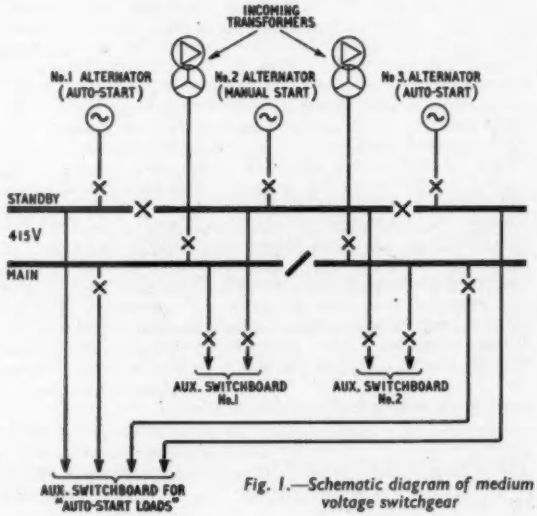


Fig. 1.—Schematic diagram of medium voltage switchgear

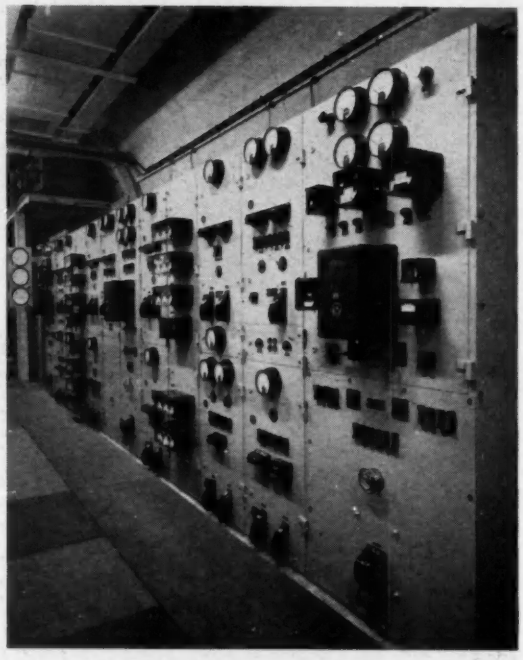


Fig. 2.—Medium voltage switchgear

is achieved by means of electrical intertripping between the control circuit of the selected alternator and both mains circuit-breakers.

The automatic starting equipment for the engine discriminates between the signal indicating a complete failure of the mains and that resulting from a low mains voltage. In the event of complete failure of the mains, the engine is started immediately. In the case of low mains voltage a delay of approximately two seconds is introduced to avoid unnecessary starts due to switching surges, etc.

When the engine is up to full speed, the alternator voltage will build up under control of the automatic voltage regulator. On reaching the normal operating range, the voltage relay will operate and, by means of a timing relay, the alternator voltage is allowed to settle down before the load is applied. Having completed the delay, the relay prepares the circuit of the closing contactor for the standby air circuit-breaker, opens the trip coil circuit on this breaker and trips the two mains air circuit-breakers.

When both mains breakers have been tripped out, the closing circuit to the standby breaker is completed, thus allowing it to close and the alternator to take the load.

Provision is made for the parallel running of all three diesel alternator sets if required. Synchronising is by means of manual control, but parallel running with the supply authority's mains is prevented by the duplicate busbar arrangement and the interlocking features already described.

The lubricating oil systems of the two auto-start engines are intermittently primed by a combined pump and gravity system whilst the engines are at rest.

Mains Restoration

Restoration of the mains supply will pick up the mains failure relay and operate the master control relay, which lights up the "mains on" indicating lamp. The standby

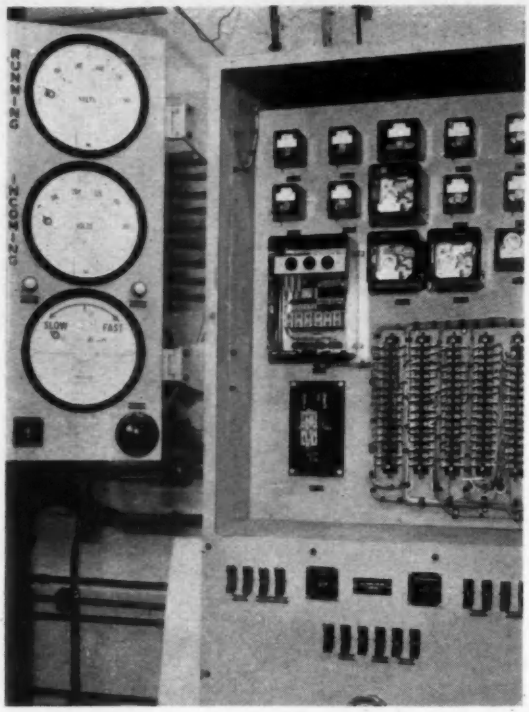


Fig. 3.—Part of the medium voltage switchboard showing the auto-start control and relay panel

breaker is then tripped manually by pushbutton and the mains circuit-breaker is reclosed by hand. Electrical interlocks prevent the reclosure of the standby breaker in the interval between its being tripped and the mains breaker closing.

On closing the mains circuit-breaker, the circuit of the closing contactor of the standby circuit-breaker is opened, and the control circuit has to be re-set manually before the breaker can be reclosed. This ensures that the complete mains failure sequence is carried out before it is possible to reclose the breaker. An engine failure will be detected by its own monitoring circuit, which is arranged to give an initial warning and shut down the set if the fault persists.

Mains failure can be simulated by means of a push-button which carries through the starting sequence already described. The testing of the engine control circuit and alarms can be carried out by means of a second push-button, without causing a change-over of the load.

Control and Tripping Supplies

Two 25 Ah, 50 V "Nife" nickel-cadmium alkaline batteries, equipped with control and charging equipment, have been provided to maintain the continuous indicating load under mains failure conditions and also to supply the power for the engine control and alarm equipment and carry out the necessary switch closing and tripping operations.

The control equipment is so arranged that, under normal conditions, the continuous loads will be supplied from the rectifier contained in the control and charging cabinet. The equipment also has facilities for selecting either of the two batteries for duty, the selected battery floating across the rectifier output on continuous trickle charge. The battery not selected for duty can be left on open circuit or given a quick-rate boost charge.

Acknowledgment is due to the Post Office Engineering Department for permission to publish this article, and the English Electric Co., Ltd., for providing the information.

Lighting and Architecture

"WE have tended to think of daylight as in infinite supply and costing nothing and artificial light as still being very expensive," said Mr. J. M. Waldram, senior research illuminating engineer, General Electric Co., Ltd., in a lecture to the Utilisation Section of the Institution of Electrical Engineers on 7th May. "The economics of artificial light have, however, changed in a way which is not always realised. The running cost of artificial light is now less than one-five hundredth of what it was."

In a historical review Mr. Waldram pointed out that when a new device was invented for doing something which had been already done by less efficient means, the first stage in its evolution was merely to use the new device to do the old job, without thinking out the problem afresh. Gas and oil lamps, like candles, had to be accessible for lighting. Electric filament lamps at first followed meekly in tradition and to a large extent they still did. Any catalogue of decorative equipment today contained table and floor chandeliers, or that horrible neologism the "electrolier."

In the last few years a new approach to problems of interior lighting had been worked out in Britain which showed promise of rationalising many of the problems, both architectural and technical. It was not merely what the equipment looked like, by day or even by night, but what the interior looked like when it was lighted. The new approach, which had been called "designed appearance lighting," went far to rationalise the processes of interior lighting design. It began with the conception of the appearance of the lighted interior, perhaps in the form of a sketch. Means had been found of interpreting in numbers the architect's conception, which was of course a purely æsthetic one. It naturally found its greatest usefulness when applied to large and complex interiors, as at Gloucester Cathedral; but it had also been simplified for application to the simple rectangular interior and the arithmetic reduced to a simple work-sheet. The point had not yet been reached, however, at which everyday interior lighting could be designed by this method, for more details of available equipment and possibly new kinds of equipment and layouts would be called for before the designer was able to choose from a catalogue equipment having the characteristics called for by the calculation.

This new method of lighting opened new possibilities—and raised new professional problems. Hitherto much lighting design could be done quickly by simple rules guided by experience. This kind of design was cheap enough to be offered as a free service by the larger lighting companies, several of which carried large and experienced staffs for the purpose, which was a costly arrangement. The new approach now made possible and worthwhile a detailed design worthy of the architecture which it was to reveal, calling for well-qualified designers and taking much more of their time. But the equipment involved might be quite simple, and the situation was developing where the cost of the design could no longer be fairly given freely. It might be that some more satisfactory arrangement must be studied for covering the cost of design apart from that of the material, a scheme which might commend itself not only to manufacturers but also to consulting engineers who hitherto had been faced with skilled advice given without specific charge and had felt that their professional territory had been invaded. Mr. Waldram explained that he was expressing his personal opinion.

He concluded with a plea for the training of lighting artists, men skilled in both engineering and æsthetics, saying that recent experiences had confirmed the need. A vote of thanks was proposed by Mr. T. G. Horton and seconded by Mr. Vaughan Harris.

VIEWS on the NEWS

By REFLECTOR

I HAVE commented already upon the persistence of gas lighting in many London dwellings although we are now more than half-way through the twentieth century. I have just seen another letter, in the *Islington Gazette*, from a resident of a block of 240 tenements, complaining that although the tenants are willing to pay a few shillings a week more they are still deprived of electricity, which it would cost less than £4,000 to install. The earliest date which they have been given for the provision of this service is 1961. The writer justly says:—

> "Seeing that this is the age of Sputniks and atomic stations for producing electricity, and that we are in the very heart of the Metropolis, we feel that something should be done about the installation of electricity in these flats."

* * *

The chief danger to the picturesque rural cottage is not the erection of overhead electricity lines but the lack of the modern amenities which they provide. This fact was made clear in a short discussion I listened to at the last meeting of the Eastern Electricity Consultative Council. A representative of the Fens area, Mr. R. G. Curston, declared that good cottages in remote localities were "going to rack and ruin" because people would not live in them. "Even if we cannot have electricity, let us have the poles—they will at least help to hold the houses up!" he pleaded. The chairman (Ald. W. J. Bennett) queried whether the absence of electricity was the main reason for people leaving isolated places, saying that the tendency was to prefer to live in villages. The general view, however, seemed to be that in these days the farmer's wife is only prepared to live in a house where there is electricity—and television.

* * *

In a few weeks' time electric services are to start on the Southern Region lines between Victoria and the Kentish coast; trial runs have, in fact, already been carried out as far as Dover Priory. Referring to this in the *Dover Express*, "Recorder" says:—

> "The old resident cat at Kearsney Station [near Dover] always takes a daily stroll across the lines. He did on Tuesday morning during the time the electricity was switched on. He reached the live rail, his fur stood on end, he jumped, spat, then turned tail and made a dash for the platform."

Obviously, a cat with a sixth sense as well as nine lives.

* * *

A note in the *Evening News* states that British visitors to France will now be able to use their 220 V electric razors in that country, because "a large part of the Mediterranean coast zone has just changed over to the 220 volts 50 cycles rate, like most places in England." This is said to be "part of a vast modernisation scheme, which has already put atomic energy from the Marcoule plant into the French grid and which will culminate in the link-up between the French and British grids." All this, in view of the opening sentence, looks like an endeavour by the French to attract more tourists—with their electric shavers.

* * *

Woking (Surrey) power station has been closed down. A local paper strangely says:—"Since 1934, when Woking joined the grid tariff, the station has been uneconomical." The station was established in 1894 and at the end of its career was only of 7,000 kW capacity. A few years ago when I had occasion to pass through Woking quite frequently I always looked out for the chimney of the station upon which had been inscribed vertically: "Electrify: Your Troubles Fly." This slogan disappeared some time after the nationalisation of the industry.

* * *

From the *Financial Times*:—

> "Sir William Cook, the Authority's Member for Engineering and Production, told the opening session . . . that this advanced, gas-cooled reactor had higher heat ratings and operating temperatures than the Colder Hall reactor."

As the name bears out, of course.

* * *

Rather like an "Arabian Nights" story, the *Electrical Review* of 26th May, 1899, tells of the coming of electricity to Constantinople. Hitherto, apparently, merely to mention the word "electricity" in the hearing of the Sultan was as much as one's head was worth, His Serene Highness associating the dynamo with dynamite. Then

> "a Spaniard, Don Ramirez by name, started a circus in Constantinople, and in order to be up to date, imported a kinematograph. But the city authorities would not allow him to set his new instrument in operation, because it had to be driven by the condemned electricity. In his difficulty he applied to his ambassador, who promised to do his best for him. During the next audience which he had with the Sultan, the wily diplomatist took occasion to enlarge on the wonders of the kinematograph and interested the Sultan so much that Don Ramirez was ordered to bring his instrument to the Palace. Moving scenes from the leading capitals of Europe were thrown on the screen for the delectation of the Sultan. . . . Among the indirect results of this exhibition was that the Sultan became convinced that electricity, though produced by a dynamo or a battery, had no connection with dangerous explosives; the lucky Don got kudos and wealth, and permission was granted to him to install in his circus the first electric lighting plant in Constantinople."

Transistors on Show

Survey of the International Exhibition at Earls Court

ALTHOUGH the transistor was invented only ten years ago, it has assumed such importance in the electronic industry that some 200 papers are being read at an international convention organised by the Institution of Electrical Engineers being held at Earls Court, London, from 21st to 27th May. More interest has been shown in this convention than any other so far organised by the I.E.E. At the beginning of last week, over 1,700 delegates had registered for the convention and about 20,000 applications for tickets for the exhibition had been received from all over the world. A report of the convention will appear in our 5th June issue.

The exhibition, which is being held concurrently with the convention, was opened yesterday and closes next Wednesday. Over 70 firms from this country and abroad are taking part and their exhibits range from the raw material to the finished transistor in various applications.

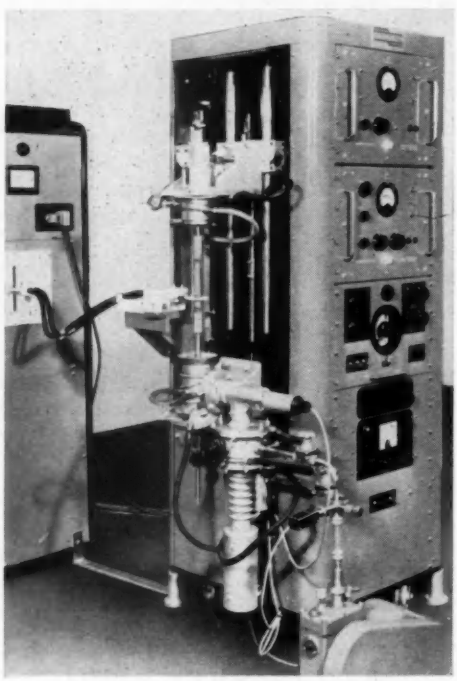
Transistor Characteristics

A semiconductor has a resistivity at normal temperatures between that of metals and insulators. This resistivity decreases rapidly with increase in temperature over a small temperature range. Semiconductors used in transistors operate below this temperature range and depend on impurities for their characteristics. If germanium is doped with antimony, an extra electron becomes available as a charge carrier since only four of the five outer electrons in an antimony atom are required to maintain the bonds with the four outer electrons of a germanium atom. This adulterated germanium is termed n-type (negatively biased). Indium atoms possess only three outer electrons so that in germanium doped with indium, spaces or "holes" for electrons appear, producing a p-type germanium.

A piece of n-type and a piece of p-type germanium can be joined to form a p-n junction which then exhibits the characteristics of a rectifier when a.c. is applied. If a piece of n-type is sandwiched between two p-type pieces of germanium, the resulting p-n-p junction can be used for amplification of signals and is called a transistor. The characteristics of n-p-n transistors are similar to the p-n-p transistor but there are larger voltage and power gains.

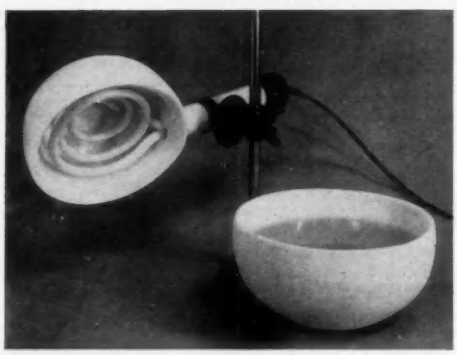
The grown junction method of making transistors has been replaced by the alloy method. In this operation, an opposite type of impurity is alloyed into the surface of a thin wafer of semiconductor material. The latest method, however, is by the diffusion of the impurities into the wafer by heating the semiconductor in an atmosphere containing the impurity as a gas.

Radyne silicon zone refining unit



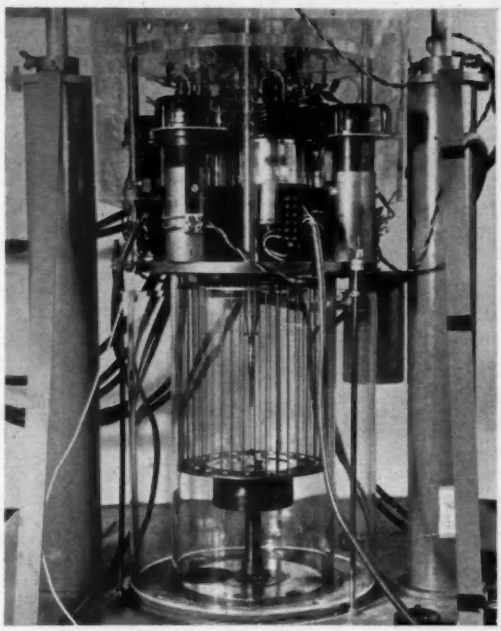
Raw Material

Transistors are commonly made from the semiconductors germanium or silicon in monocrystalline form. Although they behave in a similar manner, the choice of material for a transistor depends on its application. While silicon has a higher reverse voltage rating, suitable for power rectifiers, germanium has a lower forward voltage drop giving a higher power rectification efficiency at low voltages. The maximum junction temperature for silicon transistors is about 200 deg C and only 100 deg C for germanium. Above 100 deg C, the conductivity of germanium becomes so high that current control is difficult. Germanium transistors, however, have the advantage that they are easier to manufacture.



Heraeus surface evaporator made from quartz and using an infra-red heater

In Europe and the U.S.A., germanium dioxide is a by-product of zinc mining, while in Britain it is recovered from soot. The next stage in the manufacture is the reduction of the germanium dioxide to germanium in a hydrogen furnace. Final purification of the resulting germanium ingot is usually carried out by zone refining.



Silicon crystal pulling furnace shown by the A.E.I. Research Laboratory

Testing germanium point-contact diodes at the B.T.H. Lincoln factory

Johnson Matthey are showing various raw materials including germanium dioxide, antimony, indium, etc. Germanium ore and ingots of refined germanium are also being shown by the Union Minière du Haut Katanga. Indium antimonide is included in the range of materials shown by Mining & Chemical Products, Ltd. This firm is also showing a device using bismuth telluride and demonstrating the principle of thermo-electric refrigeration.

Samples of lump silicon for crystal pulling and silicon rods for zone refining are being shown by I.C.I., Ltd. A floating zone silicon refining unit which will handle silicon rods of 1-2½ cm diameter and 15-56 cm long is being exhibited by Radio Heaters, Ltd. The h.f. heating coil is moved over the silicon rod while the rod is rotated in a vacuum. Thus a molten zone is moved along the bar and the impurities are conveyed to the ends.

Vacuum furnaces are shown by Edwards High Vacuum, Ltd., and Barlow-Whitney, Ltd., while Elga Products are exhibiting the Elgastat Robot type B 106 washing unit for semiconductors. The Birlec pilot dryer, designed specifically for drying air and gases for transistor manufacture, is being shown for the first time. British Oxygen Gases, Ltd., are exhibiting some rare gases used in the manufacture of electronic components. Fleischmann, the U.K. distributors for Heraeus Quarzschmelze G.m.b.H., are showing quartzware for use in the production of transistor materials.

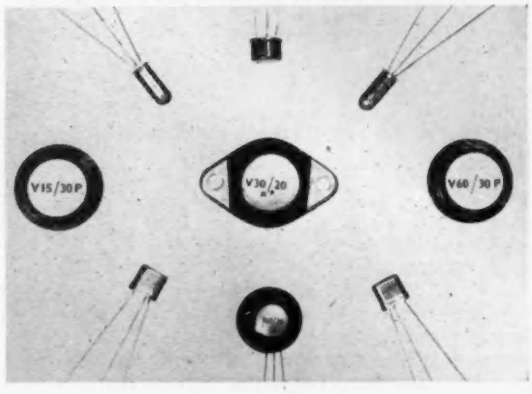
After refining, the transistor material must be formed into a crystal to obtain a perfect lattice structure. Among the exhibits of the A.E.I. Research Laboratory is a working silicon crystal pulling furnace using electron bombardment heating. Silicon crystals of very low oxygen content can be grown by this new technique. Ferranti, Ltd., are showing a model demonstrating the preparation of single crystals of silicon by growth from molten silicon on to an orientated seed crystal. In a special demonstration, Standard Telephones & Cables, Ltd., are using a closed-circuit television link to provide a microscopic view of one part of a transistor assembly operation.

Techniques for growing suitable crystals of cadmium sulphide are being shown by the University of Birmingham and the fabrication of dielectric diodes from insulating crystals is demonstrated on their stand. Designs are shown for the construction of a dielectric triode. This should combine the high output impedance of the thermionic triode with the high current output of the transistor, possess a usable frequency range wider than either of these devices, and be able to operate up to relatively high temperatures.

Transistor Types

A major factor limiting the cut-off frequency of a transistor is the thickness of its base layer, which determines the distance and, therefore, the transit time of minority carriers, between emitter and collector junctions. A new series of r.f. germanium transistors

A range of Newmarket transistors



being introduced by Mullard is manufactured by an alloy-diffusion process, which makes it possible to obtain base layers only a few microns thick. Cut-off frequencies reaching 200 Mc/s and above are attainable. This firm is also showing some developments in silicon transistors. A large-scale model of an OC200 low-frequency general purpose silicon transistor shows its constructional features.

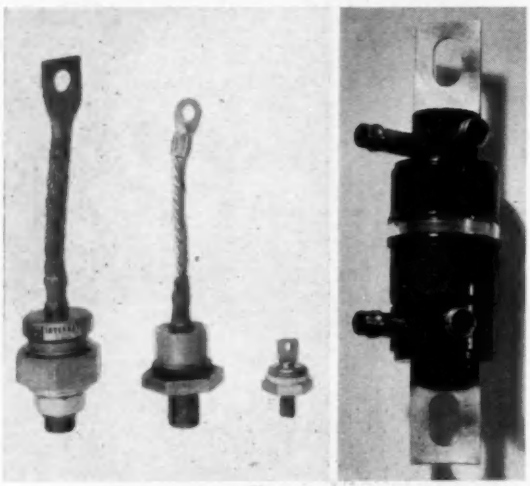
Transistors for various applications are being shown by Newmarket Transistors, Ltd., and Raytheon transistors are being shown by B & K Laboratories, Ltd. The Raytheon exhibit includes a microscope display of a unit which is claimed to be the smallest transistor in the world. Ultra-microscopic semiconductor solid circuitry is being demonstrated by Texas Instruments. Diode and transistor elements, as well as passive elements of resistance and capacitance, have been formed as integral parts of single pieces of semiconductor material both silicon and germanium. The resultant solid circuits are about the size of a match head. Semiconductors, Ltd., are exhibiting their full range of transistors for both computer and h.f./v.h.f. communication applications. R.C.A. are describing a new diode-triode which combines a transistor and an alloy-junction diode in a single unit.

The English Electric Valve Co., Ltd., are showing examples of germanium power rectifiers while a comprehensive range of metal rectifiers is displayed by the International Rectifier Co., Ltd., and by the Westinghouse Brake & Signal Co., Ltd. Joseph Lucas are exhibiting new additions to their range of silicon rectifiers. Glass seals for transistors are being exhibited by Belling & Lee, Ltd. The accent in the Plessey display of general components is on miniatures for transistor and printed circuit applications. This firm also has a small display of memory cores and matrices and transformers and various ferramics. Two improved precision resistors for use in computer networks and printed circuits are being shown by Rivlin Instruments, Ltd.

Applications

A field cable test set, utilising transistors, is being shown by the Whiteley Electrical Radio Co., Ltd. The position of breaks or short circuits in sheathed multiple conductor cables can be located to within a fraction of an inch by the use of this test set. Some of the lighting of the General Electric Co.'s stand is provided by their transistor invertor units. The latest application of these units is for motor vehicles, operating a 9in, 6 W fluorescent lamp from 12 V d.c. supplies, whilst an experimental unit, operating ten 15 W tubes from a 110 V d.c. supply, is also on view. Transistor invertors are also being shown by Elliott-Automation, Ltd.

Three large International Rectifier silicon power diodes and (right) English Electric water cooled germanium power rectifier



Electronic valves require high voltages at low current but transistors require low voltages and high currents. This requirement can be supplied by a low-voltage battery but means are required to regulate the supply. A stabilised power supply unit, using transistors, is shown by Burndept, Ltd. It is mains energised, the output voltage is adjustable and it has good voltage regulation. Transistor regulated supply units are also being shown by Roband Electronics, Ltd.

The Ferguson Radio Corporation, Ltd., are showing a servo-motor controller using transistors. The speed of the servo-motor can be controlled by this unit to within ±2 per cent. Radio equipment using transistors is being shown by Pye.

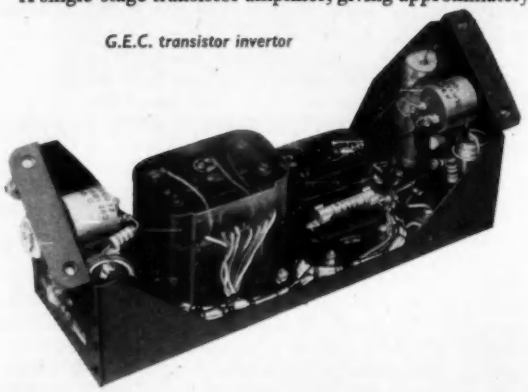
An experimental beat-frequency oscillator shown by the Ministry of Supply illustrates how, by exploiting the switching properties of transistors, both in the primary oscillators and in the circuit for deriving the wanted difference frequency, an excellent overall performance may be obtained with simple and easy-to-design circuits. A wave analyser, using transistors, can be seen on Livingston Laboratories stand. Relays, using transistors, are being shown by the Dependable Relay Co., Ltd.

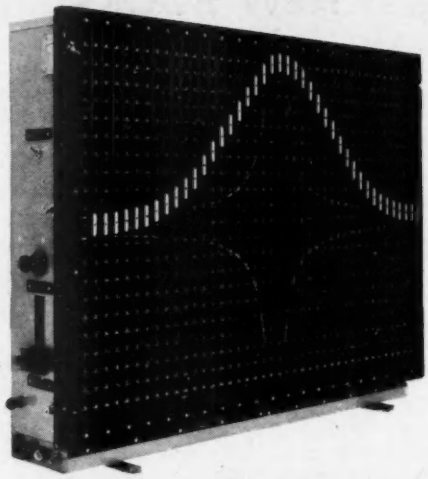
The central exhibit on the United Kingdom Atomic Energy Authority's stand is a sensitive transistor oscilloscope with d.c. to 300 Mc/s response. This performance is achieved by using the sampling principle of operation where a repetitive waveform is sampled for a very short interval, once for each repetition. By slowly changing the instant of sampling in relation to the waveform itself, the whole of the waveform is examined progressively. The amplitudes of the samples thus obtained are displayed on a cathode-ray oscillograph by a series of dots which builds up a picture of the waveform under observation. The time resolution of this system is determined solely by the duration of the gating pulse which controls the sampling action and, in the present case, an avalanche transistor pulse generator is used.

A Fourier transform generator displaying cosine and sine transforms of any function which can be represented by not more than 41 equally spaced ordinants is being shown by the British Broadcasting Corporation. The slider of each of the 41 potentiometers has to be set to the value of the function of the corresponding ordinant. Either the sine or cosine transform can be selected by means of a switch.

A single-stage transistor amplifier, giving approximately

G.E.C. transistor invertor





Fourier transform generator shown by the B.B.C.

20 dB amplification of received speech and contained within the hollow handle of a telephone hand-set, is shown on the General Post Office stand. Volume control is mounted in the receiver housing and the power for the amplification is drawn from the line. A hearing aid which is now being issued under the National Health Scheme is also shown on this stand. The amplifier circuit consists of four grounded-emitter stages, resistance-capacity coupled and stabilised against temperature changes. The current gain is about 105 dB, substantially independent of frequency over the operative range.

The pre-set counter shown by Racal Instruments, Ltd., has been specially designed for industrial use where high inherent reliability is essential. The unit incorporates a counting technique which uses transistors and ferrite cores and is intended for use where it is necessary to obtain a signal at the completion of a predetermined count.

A frequency meter, utilising transistors and intended for direct frequency measurement of signals of widely differing angles and waveforms within the range of 10 c/s and 30 kc/s, is shown by Dawe Instruments, Ltd. When used with the firm's photo-transistor pick-up, the unit provides a means of directly measuring rotational shaft speeds up to 100,000 r.p.m.

A unit for attaching to Venner frequency meters is being shown on the Venner stand. It enables measurements to be made up to a frequency of 1 Mc/s on 100 kc/s instruments, and consists essentially of a scale-of-ten transistor megacycle divider preceded by a megacycle pulse shaper and emitter follower stage presenting a high input impedance to the signal.

Miniature mercury primary cells are shown by Mallory Batteries, Ltd. This company now has in hand a cell which will have a capacity of 37 mAh in only $\frac{1}{50}$ cu in. Ferranti, Ltd., are demonstrating small storage batteries being charged by means of solar cells while a thermo-electric generator is being shown by Wayne Kerr.

Liquid Fuel Firing

AMONG 19 papers presented at a conference organised by the Institute of Fuel (11th to 14th May) on major developments in liquid fuel firing between 1948 and 1959 were two concerning the power stations of the Central Electricity Generating Board. The first, by Messrs. K. E. Dadswell and F. R. Thompson, dealt with problems arising out of the conversion of boilers designed essentially for coal firing to the burning of residual oil (18,000 to 18,450 B.Th.U/lb gross) derived from Middle East crude oil. The main technical concern, the authors stated, had been high sulphur content (4·7 per cent max) which could not as yet be eliminated at source. Vanadium (0·006 to 0·014 per cent), also irremovable at source, if increased and especially if combined with sodium (0·003 to 0·060 per cent), might cause deposits on and corrosion of uncooled metal surfaces on some boilers (e.g. superheater supports).

Two weeks' storage capacity was usual in welded tanks fitted with heating coils to maintain a discharge oil temperature of 120 to 140 deg F. Further heating to the pressure and temperature required for atomising at the burners was usually done by steam. Where boilers had plain tube furnace walls the pulverised coal burners were most economically replaced by circular oil burners, which must be placed in the furnace corners to obviate major modifications. The main problem was to narrow the flame angle to avoid flame impingement on the walls.

Steam atomising had not generally been favoured, chiefly owing to uncertainty as to its steam consumption, and it had not been used for Bailey wall furnaces, which could more economically be adapted to pressure atomising. An oil pressure of about 500 lb/sq in was usual, but for units of above 1,000 klb/hr a pressure of 1,000 lb/sq in was contemplated. Reliability of flame-failure detection equipment had been greatly improved but could be better. Steam or air purging on shut-down was essential to prevent choking by carbonisation in the burner tips. Most ignition devices were of the low-voltage high-energy spark type, but an electrically ignited propane-gas flame had been developed which served all the burners (instead of one or two) in each corner. These features were all included in an automatic operation sequence.

Increased heat absorption in an oil-fired furnace caused a lower furnace gas leaving temperature, resulting in a lower final steam temperature which had called for correction by various means. The higher hydrogen content of oil normally caused a greater moisture loss than with coal, thus tending to offset the gain due to the use of ashless fuel. The need to operate at a high final gas temperature gave a lower gross efficiency—typically 85·50 to 88·15 per cent compared with 88 per cent with coal of 10,500 B.Th.U/lb.

In modern power station boilers the feed temperature to the economiser normally exceeded 300 deg F, at which the wall temperature of plain steel tubes was about 5 deg F above the water temperature and 20 to 40 deg higher where cast-iron sleeves were shrunk on mild steel tubes. There was thus little risk of corrosion in this part even with oil of high sulphur content.

Two approaches to the protection of air heater surfaces against corrosion were described in detail. One method was to design the air heater so that the minimum metal temperature at the cold end was above the dewpoint of the gases; this entailed the provision of progressive additional heating surface for the same exit-gas temperature as the desired metal temperature increased; several means of doing so were described. One way was to pre-heat the inlet air by steam bled from the turbine at

32 to 40 lb/sq in, the latent heat of which was thus saved after doing some mechanical work; the consequent improvement in cycle efficiency could very often offset the adverse economic effects of elevated boiler exit-gas temperature. The second approach was the use of corrosion-resisting materials or coatings for the cold end, the disadvantages of which were generally higher cost and bulk and need for careful handling.

Boiler Plant Corrosion

In a paper on corrosion and deposits in boiler plants fired by residual fuel oil, Dr. H. E. Crossley discussed the most effective means of their prevention. The former evil could be mitigated by using the minimum of excess air and maintaining metal temperatures high enough to avoid condensation of acid not only in the air preheaters but also, through raising flue gas temperatures, in other parts such as ducting and precipitator casings and electrodes. High gas temperatures were ineffective during periods of shutting down boilers or putting them on load and other supplementary measures were then called for.

Corrosion of mild steel in air heaters was most likely at 50 deg F below the dewpoint of the flue gases, which was most commonly about 260 deg F. Probably some power stations using oil would be operating temporarily with a final flue gas temperature of 400 deg instead of the usual 320 to 340 deg F with consequent loss of efficiency. Additives could be regarded only as undesirable palliatives (and some of them increased deposits); of the various types, zinc oxide smokes were to be preferred. The foregoing comments, the author stated, applied to residual fuel oil as now supplied with sulphur contents of 3 to 4½ per cent. Above 3 per cent the formation of sulphuric acid was greatly increased, whereas below 2 per cent it caused no serious trouble.

Deposits on superheaters due to oil ash had not presented a major problem so far because the gas and metal temperatures were generally too low to permit fusion, but long terms of operation without cleaning would be required to assess the overall effects. The best method of preventing trouble, it was suggested, was to limit the amount of sodium in fuel oil to less than 10 parts per million at the refineries. At temperatures above 1,050 deg F, however, sodium compounds could cause corrosion of steel, particularly at uncooled metal supports of superheaters or at local hotspots.

The full-scale investigations described were being carried out on a number of boilers in view of the C.E.G.B. programme to convert 13 power stations to oil firing. These began with Marchwood in December, 1955, which was followed by Barking " C " in September, 1957. The only C.E.A. station previously designed exclusively for oil firing was Bankside " B " which, like other such stations overseas, had suffered from blockage of gas passages and corrosion of air heaters. Here the attainment of the superheat required had entailed increasing the mass flow of gas to a point at which it contained 6 per cent of oxygen. This had necessitated washing the air heaters at least every 500 hours and caused 10 per cent loss of tube thickness on each occasion. Modification of the boilers enabled the desired superheat to be achieved with 3 per cent of excess oxygen accompanied by considerably less sulphuric acid in the gases due to oxidation of SO_2 to SO_3. At Marchwood a reduction of excess oxygen from 3 to under 1 per cent had resulted in lowering a SO_3 content of 20 p.p.m. to between 2 and 7 p.p.m. and the dewpoint from between 270 and 320 deg F to between 240 and 255 deg F. This experience had been confirmed at other power stations, of which particulars were given.

NEW BOOKS

The Performance and Design of Direct Current Machines. 3rd edition. By Dr. A. E. Clayton. Revised in collaboration with N. N. Hancock. Pp. 516; figs. 314. Sir Isaac Pitman & Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 40s.

The third edition of this widely accepted textbook on direct current machinery was revised by the late Dr. A. E. Clayton in collaboration with Mr. N. N. Hancock, and several changes have been made. The rationalised M.K.S. system of units is now used for the general theoretical treatment, the chapter dealing with insulation has been completely rewritten, using more up-to-date material, and photographs of more modern machines have been used for the illustrations. Eddy current losses in deep armature conductors are now dealt with in a supplementary chapter, and the section covering the physical limit of d.c. machine outputs has been extended. Considerably more attention has been paid to duplex lap windings, used on machines having very large outputs, and further information is given on temperature rise curves. This edition of the book, which will be helpful to all those dealing with d.c. machines, in addition to those studying for B.Sc.(Eng.) degrees or H.N.C. examinations, maintains the high standard set by the earlier editions.—T.R.W.

Radio Circuits. A Step-by-Step Survey. Fourth edition. By W. E. Miller. Revised by E. A. W. Spreadbury, associate editor of the *Wireless and Electrical Trader*. Pp. 172; figs. 84. Published by Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 15s net.

This book explains in simple language and in easy stages all the types of circuit found in radio receivers used for sound broadcasting. It does this by taking separately each stage of the receiver and explaining it without the complication of all the associated circuits. After sufficient individual parts have been explained, their mutual association is dealt with, and so the reader is given an understanding of the complete receiver circuit.

Since the last edition was published, several fundamentally new techniques have been developed, and these have given Mr. Spreadbury considerable scope in revising the book for the fourth edition. He has taken full advantage of this in bringing the book up to date, and it now covers all types of receivers, including car radio, frequency-modulated receivers, and those using transistors.—T.R.W.

BOOKS RECEIVED

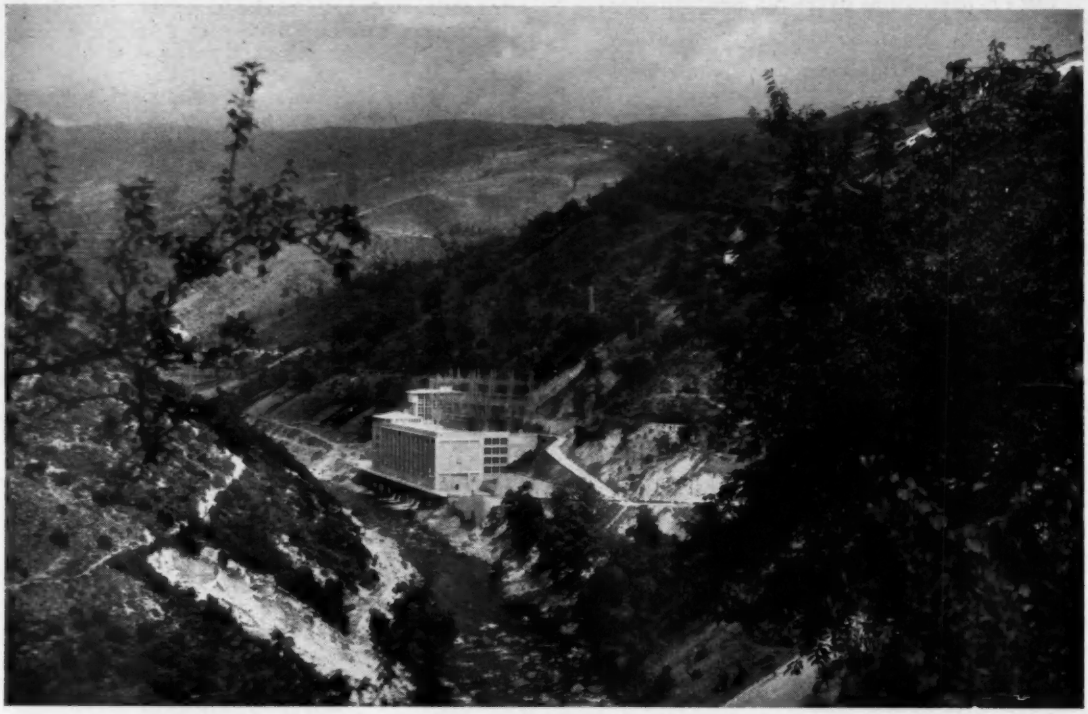
Fundamentals of Transistors. 2nd Edition, revised. By Leonard M. Krugman. Pp. 168; figs. Chapman & Hall, Ltd., 37, Essex Street, London, W.G.2. Price 25s.

Semiconductors. Edited by N. B. Hannay. Pp. 767; figs. Reinhold Publishing Corp. Chapman & Hall, Ltd. Price 120s.

First Year Electrical Theory. By Dr. D. O. Bishop. Pp. 195; figs. 107. University Tutorial Press, Ltd., Clifton House, Euston Road, London, N.W.1. Price 9s.

Magnetic Sound Recording. Theory and Practice of Recording and Reproduction. By D. A. Snel. Pp. 230; figs. 162; 16 photopages. Philips Technical Library, Netherlands. Distributed by Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, W.8. Price 25s.

World Railways 1958-1959. Fifth Edition. Edited and compiled by H. Sampson. Pp. 358; figs. Sampson Low's "World Railways," Ltd., 25, Gilbert Street, London, W.1. Price 105s.



PORTUGAL *A CHALLENGE TO BRITISH EXPORTERS*

The Portuguese Government's current six-year plan, which envisages an expenditure of some £850 million, includes important electrification projects. The recent record of Portugal as a market for electrical equipment and the prospects for British manufacturers are examined

A WEEK today, the President of Portugal will open the British Trade Fair in Lisbon. The Fair will last until 14th June and over 500 British firms, including more than 100 electrical manufacturers covering every aspect of the industry, will be showing their products directly or through agents in the new exhibition centre on the banks of the River Tagus. Domestic electrical appliances and radio and television sets selected by the Council of Industrial Design will also be an important feature of the large Government display. In all, the 140 stands will cover an area of 11,000 sq metres both inside and outside the exhibition buildings. Documentary films with commentaries in Portuguese will be shown continuously and coloured slides of major achievements of British industry will be projected on to a massive screen visible to all who enter the exhibition hall. Another new departure will be nightly broadcasts of news from the Fair over the Portuguese television network, by an independent British programme contractor, Associated Rediffusion, Ltd. As at previous overseas fairs organised by the Federation of British Industries there will be an impressive programme of supporting events, including an Anglo-Portuguese military tattoo, an international football match, and performances of Shakespeare and British music. Her Royal Highness the Princess Margaret will visit the Fair during her stay in Portugal in June.

Above: Vila Nova power station and substation. The water turbines and electrical equipment were supplied by the English Electric and Metropolitan-Vickers

Though the market offered by Portugal is small compared with the principal Commonwealth countries, there are special ties that link Portugal and the United Kingdom. Portugal is traditionally Britain's oldest ally and the history of trading relations between the two countries stretches back over six hundred years. Britain is the largest buyer of Portuguese produce, and until 1955 was Portugal's biggest foreign supplier. This position has been lost to West Germany whose sales to Portugal in 1957 were nearly 25 per cent above those of the United Kingdom. British electrical manufacturers have been rather more successful in maintaining their position than British manufacturers as a whole but they still ceded first place to West Germany three years ago, as can be seen from Table 1.

The force of German—and other Continental competition—is more clearly seen by examining the imports of selected items in 1957, the last year for which complete returns are available. Out of the total of £249,000 worth of rotating electrical machinery imported West Germany

TABLE I.—PORTUGUESE ELECTRICAL IMPORTS (£ million)

	Total	United Kingdom	West Germany
1955	5·8	2·2	1·9
1956	6·6	2·2	2·8
1957	8·2	3·3	3·5
1958	n.a.*	3·2	3·6

* Not available.

supplied £89,000, followed by the United Kingdom (£69,800), Switzerland (£21,000) and France (£20,000). Imports of switchgear amounted to £196,000, of which £71,600 came from France, £47,600 from the United Kingdom and £31,800 from Switzerland. France (£65,500) was also the principal supplier of transformers followed by West Germany (£51,600), the United Kingdom (£49,800) and Holland (£29,000), the total imports being £296,000. West Germany's greatest success, which appears to have been repeated last year, was in the supply of radio and television equipment. Out of the total imports of £1,360,400, Germany supplied £778,100, Italy £266,400 and the United Kingdom £69,000. The United Kingdom was the largest individual supplier of washing machines (£22,700 out of a total of £55,000), followed by West Germany (£13,500).

Last year's fall in British exports to Portugal was the first since 1953 and the only category which did not follow the general trend was telegraph and telephone equipment which increased by nearly £500,000 to £1,705,000. Portugal has, as a member of the Organisation for European Economic Co-operation, liberalised 93 per cent of her trade, but bilateral quotas are negotiated annually with the United Kingdom for three items of electrical equipment: smoothing irons, wires and cables of types not made in Portugal, and wiring and installation accessories. Local industry is, however, protected in certain instances by high tariffs.

The decline in Britain's position is not only undesirable in itself but because Portuguese engineers are likely to become out of touch with British developments. It is, for instance, clear that some of the criticism levelled against British equipment and manufacturers, such as long delivery and poor appearance design, are based on past experience and in many cases no longer apply. Price is the main deterrent to increased sales of British equipment. Nevertheless, the success of Germany and other Continental countries would seem to owe much to the determined and continuous sales effort that they have applied to this market and to their willingness to assist and co-operate with Portuguese engineers at the planning stage. Though it is not difficult to find British companies whose enterprise in Portugal has been well rewarded, British manufacturers as a whole have evidently not devoted sufficient attention to this market.

Three 57·4 MVA English Electric reaction water turbine generating sets at Castel del Bodo

The support given to the British Trade Fair is an encouraging indication that this deficiency is realised, and the type of equipment and apparatus being exhibited shows that Portuguese requirements have been well studied. As Sir Norman Kipping recently remarked, Portugal will for the period of the Fair "become the centre of focus of a large concentration of attention" by British industry.

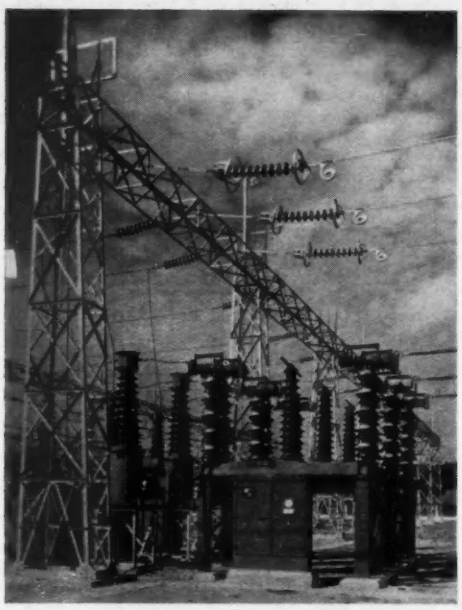
Six-Year Development Plan

The time is particularly auspicious for launching a drive for an increase in British exports, since 1959 is the starting point for the Portuguese Government's Six-Year Development Plan. This provides for the expenditure of £263 million in metropolitan Portugal and a further sum of £588 million is expected to be invested by private interests in projects outside the plan. About 20 per cent of the Government expenditure is allocated to electricity supply and production is to be increased by 1,842 million kWh.

Since the war great efforts have been made to exploit Portugal's water power resources which are well distributed over the country. As can be seen from Table 2 the output of power from hydro-electric stations increased nearly six-fold between 1950 and 1958, when it accounted for 94 per cent of the total. It has been estimated that the developed and undeveloped hydro-electric resources combined would provide a total annual output of 19,000 million kWh.

The new 180 MW station at Picote, which represents the first stage in the development of the Upper Douro, was officially opened last month. It is expected to have an average annual output of 1,000 million kWh. Work has already started on the second stage, consisting of the 150 MW Miranda station with an annual output of 800 million kWh. The final stage—the construction of the Bemposta dam and power station with an annual output of 960 million kWh—is also included in the current six-year development plan but work has not yet begun. A station on the Upper Rabagao, with a final annual output of 1,400 million kWh, and the 30 MW station at Tavora, are expected to come into operation in 1961-62.

Though the annual output of the thermal power stations is normally only a small part of the total, they are an important insurance in periods of drought (see, for example, 1957, Table 2) and £2 million is allocated for thermal plant in the development plan. A second 50 MW generating unit is to be commissioned by 1962 in the new Tapada do Outeiro station on the River Douro, which is designed to burn poor grade coal from the local coalfield. The first unit was commissioned last year and reference has been made to a third stage incorporating a 100 MW generator. Most of the other thermal stations burn imported fuel and are situated in Lisbon and Oporto. In 1958 "autoproducers" owned 90 MW of the total capacity of thermal plant shown in Table 2 and they accounted for 100 million kWh of the total output. The output from hydro plant owned by "autoproducers" (15 MW) was about 10 per cent of the total hydro output.



Metropolitan-Vickers 165 kV air blast circuit-breakers in the Zezere substation

No important new diesel-driven plant has recently been installed or is proposed.

Practically all the generating stations are interconnected through a national grid with lines at 220 kV, 150 kV, 130 kV and 60 kV, operating at a frequency of 50 c/s. There is a 220 kV line, 240 km long, from the Picote hydro-electric station to the Coimbra substation in the centre of Portugal, from which 150 kV lines run to Zezere and Lisbon. Two 220 kV lines, each over 200 km long, are under construction or planned from the Picote and Miranda stations to a substation near Oporto. A line at 220 kV will also run 30 km from Pocinho across the border to connect with the Spanish network at Saucelle. The movement of power through the grid is mainly southward. Under the six-year plan, which allocates £19 million to transmission and distribution, the distribution network will be enlarged by about 10,000 km and it is hoped to connect 200,000 new consumers to the system.

About 92 per cent of the national electric system is controlled by a National Load Allocating Bureau on which the State and practically all the generating and supply companies are represented. This bureau prepares co-ordinated long- and short-term generation programmes on the basis of overall efficiency, availability of water, guarantee of supply at any moment, etc. The exploitation of hydro-electric resources is in the hands of a number of private companies which have been granted concessions by the Government, and in which the Government is a minority share or debenture holder. This also applies to the Companhia Nacional de Electricidade (C.N.E.) which is responsible for the construction and operation of the grid.

In addition to electricity supply, £10 million is to be spent over the next six years on completing the electrification of the Lisbon-Oporto railway north of Entroncamento, and by 1961 a further route will be added to the Lisbon underground at a cost of £2·5 million. Diesel locomotives are to be bought for other lines, and telecommunication and signalling systems are to be modernised. The telephone system is to be enlarged and modernised at a cost of £8·7 million and there are extensive plans, amounting to £87 million, for the development of basic industries such as steel production, chemicals, refineries and wood pulp and paper. The enlargement and reorganisation of industrial activity generally is a priority undertaking within the plan.

Because of the large reserves of hydro-electric power there is as yet no need for nuclear energy for electricity production and Government spokesmen have made it clear that they are not interested in acquiring a nuclear power station before 1965. Nevertheless, progress in this field is being closely followed and all nuclear research and development is being co-ordinated and organised by the Junta da Energia Nuclear. This Board's laboratories will contain a swimming pool reactor supplied by A.M.F. Atomics, Inc., a Van de Graaf machine and a Cockcroft and Walton particle accelerator of U.S. and Dutch manufacture and a pilot separation plant. It is also intended to build during the next six years and at a cost of over £3·7 million a plant for the production of 200 tons of uranium metal a year from local ores. Many Portuguese students are using training facilities in this country and there is close co-operation with the United Kingdom Atomic Energy Authority. Last year a company—Companhia Portuguesa de Industrias Nucleares S.A.R.L.—was formed by various industrial interests, including ten electricity companies, to exploit the possibilities of nuclear energy in Portugal and to act as general contractors for the construction of nuclear plant.

TABLE 2—ELECTRICITY SUPPLY IN PORTUGAL

Year	Capacity (MW)		Output (10^6 kWh)		Investment (million escudos) (1,000 esc. = £12·5)		
	Thermal	Hydro	Thermal	Hydro	Thermal	Hydro	Transmission and Distribution
1950*	193	153	505	437	—	—	—
1956*	207	726	138	2,026	72	446	219
1957*	209	729	313	1,823	90	555	349
1958	260	910	150	2,480	100	450	400
1960	260	910	150	3,250	28	472	250
1963	310	1,270	150	4,230	28	472	250

* Actual figures, the rest are estimates. Source: O.E.E.C.

British Contributions

In the immediate post-war years British industry played a major part in helping to develop the hydro-electric resources of Portugal. Before the C.N.E. and the two companies responsible for exploiting the Zezere and Cavado rivers were formed in 1945, the English Electric Export & Trading Co., Ltd., and Metropolitan-Vickers Export Co., Ltd., sent a joint engineering mission to Portugal to confer with the Portuguese engineers who had been appointed to study various hydro-electric projects. Comprehensive proposals were put forward by the "British Group," as it became known, and after further discussion contracts were placed for the supply and erection of hydraulic and electrical plant at the generating stations at Castel del Bodo (172·2 MVA) and Vila Nova (96 MVA) and for switchgear for the 165 kV substation at Castel del Bodo. The development of Cabril higher up the River Zezere followed a few years later and a contract for the power station plant and equipment was again placed with the British Group. In connection with this work British Insulated Callender's Cables, Ltd., supplied and erected the first 150 kV line in Portugal from Castel del Bodo to Lisbon, and they later built a 130 kV line from Lindosa to Oporto. Ferranti supplied the power transformers for the Sacavem substation outside Lisbon.

In tendering for the stations built under the first six-

year plan, which started in 1953, British firms were underbid by Continental manufacturers. A determined effort is, however, to be made to participate in future projects. The chance of further work on transmission lines is, however, effectively excluded by the fact that the C.N.E. now constructs its own towers from imported steel and steel-cored aluminium cable is available from two local factories with French and Swedish connections.

There is a similar unhappy tale in relation to railway electrification. High British prices resulted in the contract for the electrification of the Lisbon-Entroncamento section of the Lisbon-Oporto railway going to a group of Continental firms. Electrification is at 25 kV, 50 c/s a.c. and in tendering for the completion of the scheme British manufacturers should be assisted by the work they are now doing for British Railways. The contract, worth £200,000, for power supply, ventilating and pumping equipment, received by the General Electric Co., Ltd., in 1955, was the only contract awarded to a British company in connection with the first Lisbon underground railway. However, the G.E.C. last year obtained an order for 1,500 V d.c. traction equipment for three new four-coach trains and four trailer coaches to be built in Portugal for the Lisbon-Estoril railway. The total value of the work done by the G.E.C. for this company since 1950 amounts to some £750,000. During the past 25 years Metropolitan-Vickers have supplied 200 sets of electrical equipment to Lisbon tramways and last year they received an order for the e'ectrical equipment for 20 trolley-buses for Oporto. The overhead equipment was supplied and erected by B.I.C.C., who also supplied the 33 kV impregnated pressure cable connecting the Lisbon tramway system to the grid substation. In the industrial field an important order secured by English Electric earlier this year was for three motors of 400, 600 and 800 h.p. and their control gear for a new tyre factory.

The importance of Portugal as a link in the international telecommunications network has led to British firms taking a prominent part in the development of Portugal's internal telephone system. The Anglo-Portuguese Telephone Co. holds a concession to operate in the Lisbon and Oporto areas, the rest of the country being served by the Portuguese Post Office (C.T.T.). Virtually all the public automatic exchanges in Portugal were manufactured by the Automatic Telephone & Electric Co. and the company recently supplied and installed in conjunction with Marconi's Wireless Telegraph Co. a u.h.f. frequency-modulated wide-band radio telephone link across the Tagus from Lisbon to Montijo. Another important telephone contract, valued at over £1·6 million, which is now almost completed, is the Lisbon-Oporto coaxial cable system being supplied by Standard Telephones & Cables and its Portuguese associate Standard Electrica S.A.R.L.

Portugal's first trolley-buses began operating in Oporto this year. The traction and control equipment was supplied by Metropolitan-Vickers and the overhead installation by B.I.C.C.

Local manufacture of electrical equipment has increased rapidly, often with foreign help, and a wide range of equipment is now made. The main exceptions are steam, gas and water turbines, alternators and generators, industrial electronic equipment, radio and television apparatus and electro-medical equipment. The Automatic Telephone & Electric Co. established a subsidiary, Automatica Electrica Portuguesa, in 1945 and this now manufactures complete private branch exchanges, small automatic exchanges, telephone instruments and some parts of main automatic exchanges. Telephone cables and power cables up to 30 kV are made by an associate company of B.I.C.C.

TABLE 3.—PORTUGUESE ELECTRICITY CONSUMPTION BY SECTORS (10^6 kWh)

Year	Industry	Traction	Lighting	Domestic	Agriculture
1956*	1,346	81	46	392	8
1957*	1,256	95	51	438	10
1958	1,597	120	55	500	12
1960	2,118	130	65	630	14
1963	2,680	140	80	890	18

* Actual figures, the rest are estimates. Source: O.E.E.C.

The generally low standard of living limits the market for high quality domestic appliances to a small section of the population. Most of the well-known makes of British and Continental appliances are available and competition is accordingly extremely fierce. There is also some local manufacture of small appliances. Last year British manufacturers succeeded in selling £132,000 worth of domestic appliances (excluding refrigerators) to Portugal, which was slightly more than in 1957. Space heaters, washing machines, irons and food mixers were among the more important individual items.

A new element in this field is the recent establishment by the General Electric Corporation of America of a subsidiary to manufacture a wide range of domestic appliances. The company have been authorised to begin manufacture in their present maintenance workshop but they are also to put forward a plan for a new factory outside Lisbon. It should be possible for them to manufacture locally-made appliances at prices well below those of imported goods, but if they fail to do so they may well successfully appeal for tariff protection. Nevertheless, the market is at present open and those British manufacturers who have established themselves in the Portuguese market are confident of expanding their sales. Also a large appliance manufacturer, who has not previously been active there, has decided, after conducting an extensive survey, that the future prospects are sufficiently encouraging to warrant a long-term sales effort.

These details of some of the more important work done by British electrical manufacturers in Portugal since the war, when taken with the general level of exports, are sufficient to show that their record is not as black as it is sometimes painted. It could, however, be better and next week's Trade Fair will be a useful stimulus. Its success will, however, depend on the extent to which manufacturers exploit the advantage that it will give them. In Portugal as in most other export markets today a satisfactory level of business can be achieved only by long and continuous effort.

Continuation of Progress

E.D.A.'s INFLUENCE IN MANY FIELDS

THE Rt. Hon. Thomas Johnston, C.H., the president, took the chair at the annual luncheon of the British Electrical Development Association at the Savoy Hotel, London, on 12th May, when the principal guest was Mr. Derek Walker-Smith, the Minister of Health. In proposing the toast of "Electrical Development," Mr. Walker-Smith said that he had a warm regard and admiration for the work of the electrical industry and those who served it in their skilled and diverse ways; for the valued educational work of the Association; and for the president, who had made a massive contribution to economic growth and social progress, particularly as Secretary of State for Scotland and as chairman of the North of Scotland Hydro-Electric Board.

Referring to the fact that next month the E.D.A. attained its fortieth "birthday," Mr. Walker-Smith said that it had a good record of past performance but was young enough to have the future as its main concern. In the field of health, electricity had made a great contribution to the work of the doctors and hospitals and the greater use of electricity for power and lighting would help to secure a clearer atmosphere. In that respect great hopes were entertained for the prospect of the development of plentiful electricity from nuclear energy.

Rural electrification had made progress gratifying beyond expectation; of some 275,000 farms in England and Wales well over 200,000 now had a supply and were thus able to take advantage of electrical techniques with their resulting economies in operating costs. On the domestic side, too, progress had brought about a silent revolution and had bestowed on the many things confined, only a generation or so ago, to the favoured few.

We were still under the impulse of a ferment of ideas, ingenuity and inventiveness. Only by being in the van of scientific and technical invention and industrial progress could we keep our place in this fast-moving age. It was encouraging to see at the luncheon so many who were making so eminent a contribution to that work.

Replying to the toast, Mr. Johnston said that E.D.A.'s annual report on its many activities made interesting reading to everyone concerned in furthering Mr. R. A. Butler's prediction of the ability of this country to double its standard of living by 1979. What had happened in the Scottish Highlands was an indication of the effect of electricity upon the standard of living. Mr. Johnston went on to mention some of the more recent electrical achievements and made special reference to the projected pumped storage schemes at Ffestiniog in Wales and Loch Awe in Scotland.

He said that although the Weir Committee had reported against joint gas and electricity meter reading and joint showrooms, nevertheless, he thought that there was something to be said for a co-ordinated policy where the two services were being duplicated at heavy loss to both and where, in addition, there was a regular and growing supply of bottled gas. Four years ago Inverness adventured upon the first multi-storey electric flats in Great Britain, although at that time there was no off-peak tariff. This example had been followed by Kirkcaldy, Glasgow, London, Cardiff and many other corporations. This development should have a marked effect upon load factor, as would better lighting. He wished success to the British Lighting Council. The widespread co-operative use of the electric crop and hay dryer would bring immediate benefit to agriculture and substantially increase the protein value of the crop.

The Association was making considerable efforts to encourage more effective use of the Clean Air Act. Mr. Johnston suggested that the splendid film on the subject which was available should be shown to appropriate Ministries. Ministers could then perhaps explain why they gave a subsidy towards approved expenditure under the Act while collecting purchase tax on household appliances designed to abolish or diminish smoke. Mr. Johnston concluded by proposing the health of the guests.

Lord Waldegrave, Parliamentary Secretary,

Above: The Rt. Hon. J. S. Maclay (Secretary of State for Scotland), Sir Christopher Hinton (chairman, C.E.G.B.), Earl Waldegrave (Parliamentary Secretary, Ministry of Agriculture), Sir Josiah Eccles (new president of E.D.A.) and Mr. S. E. Goodall (President, I.E.E.)

Right: Mr. J. I. Bernard (director and secretary of E.D.A.), Mr. D. Walker-Smith (Minister of Health), Mr. W. N. C. Clinch (retiring chairman, E.D.A. Council), the Rt. Hon. Thomas Johnston (retiring president of E.D.A.) and the Rt. Hon. J. S. Maclay

Ministry of Agriculture, said in the course of a reply to the toast, that electricity was as important to the countryman and the farmer as it was to the townsman and industrialist. It had been said that the farmer would confine his use of electricity to a 20 W lamp in the cowshed. But E.D.A. and the Electricity Boards had changed all that and many farmers were now very dependent upon electricity. The business of taking electricity to farms was not yet complete; only about 75 per cent of the farms at present were connected, but leeway was being rapidly made up. Farmers realised that heavy capital commitments were involved and that there must be a prospect of a reasonable load.

It was the task of E.D.A. to show farmers how to secure the full benefits of electricity and the Association was to be congratulated upon the range and extent of the free assistance which it afforded farmers. There was the closest co-operation between E.D.A. and his Ministry.

The Government had already made advances to hill farmers for the installation of electricity and the new Farm Improvement Scheme would extend the scope of this assistance to other farmers. After buildings and roads and bridges, electricity took a good third place. Farmers provided a good off-peak load with their early-morning activities and thermal storage systems. Thus, modern agriculture might prove helpful to the electricity supply industry which was being so helpful to farmers.

Annual Meeting

Mr. W. N. C. Clinch, chairman of the E.D.A. Council, presided at the subsequent annual meeting when the report and accounts for the past year were formally adopted. The chairman announced the appointment of Sir Josiah Eccles, C.B.E., as president for 1959-60 and of Messrs. A. W. Ferguson, M.C., C.A., and John Mould, O.B.E., as vice-presidents for the three years 1959-62.

Sir Josiah Eccles

Mr. T. E. Daniel

Mr. D. B. Irving

Sir John Pickles, seconded by Mr. W. S. Lewis, moved a vote of thanks to Mr. Thomas Johnston, and Mr. T. E. Daniel, seconded by Mr. D. B. Irving, thanked Mr. Clinch for his services during the past year.

Finally, a vote of thanks was proposed by Mr. T. M. Ayres to the chairmen and members of all E.D.A. committees, Mr. J. I. Bernard (director and secretary) and his staff, and the technical Press. Mr. H. Pryce-Jones seconded the motion.

Afterwards a Council meeting was held at which Mr. T. E. Daniel (chairman, North Western Electricity Board) was elected chairman for the current year and Mr. D. B. Irving (chairman, London Electricity Board) was elected vice-chairman.

ROYAL SOCIETY CONVERSAZIONE

THE Conversazione of the Royal Society, which was held on 14th May, included a number of exhibits of scientific interest which were chosen by the Society's Soirée Committee under the chairmanship of Sir Lawrence Bragg, O.B.E., F.R.S. An exhibit by the University College of Swansea was concerned with the electrical activity of metal surfaces. Ordinary metal surfaces have long been regarded as electrically inorganic at room temperature under low electric fields. In fact, it has been found that an ordinary surface exhibits considerable activity, producing about 10^6 electrons/sec at room temperature under fields as low as 100 kV/cm. This activity is of practical importance as it underlines the operation of electrical equipment such as contacts, high voltage overhead lines and cables. The apparatus displayed showed a method of measuring this activity in terms of electron emission and the investigation of the dependence on the type of surface and the applied field. Polishing the surface can influence electron emission.

The electronic properties of graphite and its crystal compounds were the subject of the exhibit by the Imperial College of Science and Technology. One section of the exhibit was concerned with the anisotropic thermo-electric properties of graphite. A high-temperature graphite thermocouple was demonstrated incorporating a junction of polycrystalline and a-axis pyrolytic graphite; values of thermo-electric power have so far been measured up to 2,100 deg C. A combined exhibit by the Associated Electrical Industries Research Laboratory, Cambridge and Bristol Universities, the National Physical Laboratory and Tube Investments illustrated dislocations and other imperfections within inorganic crystals.

Other exhibits included an X-ray fluorescent spectrometer using radioisotopes as a source, electronic models in the study of cell-cell interaction, plastic behaviour of steel structures and laboratory methods designed to assist the degree of immunity introduced as a result of polio vaccine.

S.I.M.A. Luncheon

THE annual luncheon of the Scientific Instrument Manufacturers' Association of Great Britain was held at the Savoy Hotel, London, last week. After Mr. R. Barrington Brock, president of the Association, had proposed the loyal toast, he introduced the guest of honour Sir Aubrey Burke, president of the Society of British Aircraft Constructors. Mr. Brock said that during his presidency of S.I.M.A. he had tried to bring about a closer collaboration between users and makers of scientific instruments since this could result in benefit to all concerned. From the manufacturers' point of view they had to prove that instrumentation was advantageous all round. Export competition was increasing very quickly and in view of this British instruments must be publicised abroad. In conclusion Mr. Barrington Brock referred to the use of foreign cars by British salesmen when abroad and said this could be damaging to the prestige of British products generally. British industries should support each other as no single one could get on without the others.

Sir Aubrey Burke then spoke about the use of scientific instruments in the aircraft industry and outlined some of the problems with which they were confronted in this connection. In the research field the scientific measuring instrument was indispensable and he felt that British instruments compared very favourably with those produced anywhere else in the world.

The guests were welcomed by Mr. L. A. Woodhead, president-elect of the Association, and Mr. T. Fife Clark, director general of the Central Office of Information, replied.

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Teaching of Electrical Engineering

IN the *Electrical Review* of 1st May Mr. J. H. Gridley criticises several points in my article on the teaching of electrical engineering (10th April issue).

I feel bound to reply, in particular, to the second paragraph of his letter. The fact that we are "saddened" when our long-cherished misconceptions are challenged, is not a very good reason for refusing to reject them. If we keep the fact that Coulomb's Law, and the rest, no longer form an adequate fundamental basis for modern electrical engineering "a deep dark secret," as Mr. Gridley suggests, then these misconceptions will continue to be propagated in "all the leading professional journals" indefinitely. The whole point of my article on this subject is that a completely new approach is an *urgent* necessity.

With regard to his criticism of specific points. I do not agree that it is necessary to treat the vector $\mathscr{E}$ and potential gradient as separate quantities. The same situation—the non-existence of scalar potential—occurs in some cases of fluid flow and this was the main reason for introducing Fig. 1d in my article. Unfortunately, lack of space prevented the development of this point. I would, in fact, point out that it is the traditional misconceptions which make it difficult for people to appreciate this point regarding potential and potential gradient. The "other half of the story" regarding $B\frac{dA}{dt}+A\frac{dB}{dt}$ can easily be proved, if it is thought necessary, from the equation $\mathscr{E}=B\,v\sin\theta$. I would be happy to discuss these points in more detail with any reader who is interested but limitation of space makes this impossible at present.

Melbourne. A. T. CRAVEN,
Senior Lecturer in Electrical Engineering,
Royal Melbourne Technical College.

Post-Graduate Research

YOUR editorial comment in the issue of 13th March on the new higher award of the Hives Committee draws attention to an interesting aspect of engineering qualifications.

The institution of such an award has been long overdue, but now that it has arrived, one wonders if the success of the whole scheme might not prove to be abortive, because of the very anæmic choice of the name of the award, namely, Member of the College of Technologists.

Does this title even suggest equivalence to a university Ph.D. ? The Hives Committee claims that the standard will be so; the success of the qualification, however, will depend solely on its acceptance by industrial and academic circles as such—certainly neither so far has been enthusiastic about it. Its chances of acceptance as equivalent to a university doctorate would appear to be remote, when one considers that we have had for several years fellowships of various colleges, which are awarded on the basis of two or more years of research. Can it honestly be said that these have equivalence to a university doctorate in industry or in academic life ?

One wonders, therefore, why the more elegant and honest qualification, Doctor of Technology (Dr. Tech.), suggested in the Percy Committee Report, was not adopted. Here surely was a qualification that has a universal meaning, even to those outside the profession of engineering. What is more important, it has a "timeless" quality, for after the recent "scorched earth" policy on the H.N.C. who can be quite certain that in time the M.C.T. might not suffer the same fate ?

With some of these points in mind, it seems essential that the title of the award should have been such as to be recognised as equivalent to a university doctorate by reason only of its title.

It would be interesting to know whether the fact that all but one of the 12-man Hives Committee are university graduates has had any significant bearing on the choice of the name of the award. Also, what opposition, if any, did come from universities towards adopting such a title.

If the purpose of the Hives Committee was to provide a path to higher technological qualifications for Dip.Tech. students and graduates of technical colleges of university rank (who, because of university regulations, are unable to work for higher degrees, purely because of the title of their awards) it certainly has made the "prize" rather unattractive; more significantly, another closed loop of engineering qualifications has been created in a profession where too many already exist.

It is a solemn thought that one day such graduates of advanced colleges of technology and technical colleges of university rank may well go overseas to qualify for higher degrees (where incidentally their qualifications are regarded as equivalent to a first degree) and, in doing so, perhaps be lost to the engineering life of this country.

"GRADUATE ENGINEER."

The Electric Runabout's Scope

I WOULD like to be another correspondent who writes to "Reflector" on his observation that battery charging stations are necessary to make the electric runabout a practical method of transport. The correspondent who points out that all that is necessary is that the vehicle shall have its own charger, is quite right, and this makes the electric runabout a practicable method of transport.

It is not in the interests of electrical progress that it should be condemned because it has its limitations. "Reflector" is quite correct, of course, in saying that the ordinary car owner wants to go further afield than, say, 80 miles a day, but there are a growing number of families who now own at least two cars. Two of my neighbours, for example, have a large family car; in the one case, a small car is available for the mother and two daughters, and in the other, for the wife alone. The small cars are used for nothing but shopping and running about locally. Electric runabouts would be ideal. One does not say that light shoes are useless simply because they will not stand up to mountaineering, or cross-country walks in the wet.

Twickenham, Middx. R. D. REYNOLDS.

GENERATION AND DEVELOPMENT

Twenty Million Savings Stamps Sold

The North Western Electricity Board has just sold its 20 millionth 2s 6d "easy payment" savings stamp. The suggestion that the Board might try such a system was first made through the North Western Electricity Consultative Council in 1952. The stamp method was decided upon and a 1in by ¾in blue stamp was designed at the Board's Manchester headquarters. In June, 1952, the stamp scheme was introduced experimentally in 13 Lakeland Service Centres, being extended to 17 other selling points in the following September. So successful did the pilot scheme prove that in February, 1953, it was extended to all Service Centres in the Board's Area. By April, 1954, the Board had sold its first million stamps. Nearly two years later stamp machines were provided in chosen Service Centres. The scheme has continued to flourish and each month over half a million stamps are being sold.

Purchase Tax Anomalies

The Southern Electricity Consultative Council, at its meeting at Reading on 12th May, debated a resolution submitted by the North Eastern District Committee welcoming the recent reductions in purchase tax and expressing the hope that the tax on domestic appliances would later be discontinued and the existing anomalies removed. It was noted that block storage heaters were tax free on condition that they were available to industrial and commercial consumers only. The Council felt that it would assist Electricity Boards to improve their load factors if these heaters could be made available, tax free, for domestic use.

With regard to refrigerators, it was pointed out that a piece of meat could be kept fresh in apparatus bearing no purchase tax up to the time it was bought by the housewife, whose refrigerator, however, was subject to tax, and this appeared to the Council to be a somewhat arbitrary and unjustifiable imposition.

Electricity for Grain Drying

The Electrical Development Association has issued a further handbook (No. 5) in its farm electrification series. This illustrated guide to the practical design of grain drying installations first reviews the progress made in this country and emphasises the important part which electricity plays in modern practice. The basic principles are then explained and the various methods classified. Separate chapters are devoted to the operation of flow, storage and batch dryers and a further chapter deals with the electrical appliances which are concerned in drying, such as fans, heaters, and indicating and controlling instruments. Advice is given on the choice of dryer, including a useful table summarising the characteristics, performance and approximate cost of the different types.

The last chapter deals with electrical equipment for the movement of grain on the farm, and finally there is a collection of facts and data of value in connection with calculations on electric grain drying.

Copies of "Grain Drying" (E.D.A. 1833) can be obtained either from Electricity Boards' Service Centres or direct from the Association at 2, Savoy Hill, London, W.C.2.

Floor Warming Plans

Blackpool Corporation Estates and Housing Committee proposes to build 56 dwellings with under-floor heating at the junction of Squires Gate Lane and Westgate Road and a further 33 in Mansfield Road.

OVERSEAS

Uganda Training Scheme

As part of its programme to expand the training of local artisans and technicians, the Uganda Electricity Board is establishing a basic training centre at Njeru, near the Owen Falls power station. The courses will be divided into four main categories:—Condensed courses for the advancement of suitable semi-skilled employees; courses for engineering graduates, technicians, skilled operators and trade apprentices; "booster" courses; and supervisory study groups in human relations and job methods.

Canadian Water Power Resources

The Water Resources Branch, Department of Northern Affairs and National Resources, Canada, has issued its annual review of the water power resources of Canada and of their development to the end of 1958. Present recorded water power resources are shown as totalling more than 46 million h.p. under conditions of low stream flow and over 66 million h.p. at average flow, the latter figure representing a feasible turbine installation of more than 87 million h.p.

During 1958 a record total of nearly 2·5 million h.p. of new hydro-electric capacity was brought into operation, making the aggregate capacity 22·4 million h.p. The highest installed capacities are in Quebec (9·9 million h.p.), Ontario (7·2 million h.p.) and British Columbia (3·3 million h.p.). The pulp and paper industry uses about 18 per cent of the total electricity produced in Canada.

Copies of this review (Bulletin No. 2641) may be obtained free of charge from the Director, Water Resources Branch, Department of Northern Affairs and National Resources, Ottawa.

Water Power in Nigeria

The *Nigeria Trade Journal* says that the Electricity Corporation of Nigeria has commissioned Balfour, Beatty & Co., Ltd., and "Nedeco" to investigate the River Niger in the vicinity of Jebba with a view to constructing a hydro-electric plant which will ensure a cheap supply of power for secondary industries.

Power Supply in Mexico

Reporting on the company's operations in 1958, Mr. W. H. Draper, chairman of the Mexican Light & Power Co., Ltd., says that electricity sales increased by 8·7 per cent to approximately 3,000 million kWh. The rate of expansion was somewhat slower than in 1957 (11·3 per cent). Construction work was started for the installation of a fourth generating unit at the Lecheria plant, a duplicate of the third unit installed last year, which will provide another 82·4 MW of thermal generating capacity. In addition, hydro-electric power from the Federal Electricity Commission's new plant under construction on the Apulco River (initial capacity of 156·6 MW) will become available to the company for distribution by the end of 1961. With these additions, the total generating capacity of the interconnected system will be nearly 1,200 MW.

Dominican Project

The first meeting of a judging committee on proposals submitted by Dominican and overseas firms for a 135 MW hydro-electric scheme on the River Nizao was held in Ciudad Trujillo recently. The scheme will include the storage of 600 million cu m of water and provide increased water and irrigation facilities for the Ciudad Trujillo area.

Quality in Industry

A conference, organised jointly by the Institution of Production Engineers, the Institution of Engineering Inspection and the British Productivity Council, will be held at the Palace Hotel, Buxton, on 18th and 19th June next. The aim of the conference is to show that control of quality is the concern of every member of an organisation, and can be introduced at all stages of design and manufacture. The conference papers will cover the field of engineering, woodworking, textile and leather industries. Details can be obtained from the Conference Secretary, the Institution of Production Engineers, 10, Chesterfield Street, Mayfair, London, W.1. The fee for the conference is £5 5s.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

The Earl of Halsbury, F.R.I.C., F.Inst.P., has been appointed to the board of Lancashire Dynamo Electronic Products, Ltd., as chairman. He is vice-chairman of Lancashire Dynamo Holdings, Ltd., and is also on the boards of a number of other companies. He was until recently managing director of the National Research Development Corporation, a position he had held since the Corporation was set up in 1949.

Mr. D. E. Kidner has been appointed area manager of the new G.E.C. North London, Eastern and Southern Counties Area. He joined the G.E.C. in 1937 after serving four

Mr. D. E. Kidner

Mr. S. C. Sutton

years with Falk, Stadelmann & Co., Ltd. From 1937 to 1939 he acted as an outside representative for the G.E.C. Domestic Cooker Department. During the war Mr. Kidner saw service in North Africa and Italy, and on leaving the Army in 1945 he rejoined the company. After a year at Magnet Works in Birmingham, he was appointed senior assistant in the Domestic Equipment Department. From 1949 to 1953 he was the company's South Eastern Electricity Board area representative. He became manager of the Southampton branch in 1953 and was made area manager, covering Southampton and Plymouth branches, in 1958.

Mr. S. C. Sutton, who becomes assistant area manager of the new North London, Eastern and Southern Counties Area, joined the G.E.C. in 1918 and received his training in several departments at the head office. He joined the London sales organisation in 1933 and was appointed manager of the Luton establishment in 1938. Four years later he was appointed personal assistant to the London sales manager, a post which he held until 1949, when he took charge of the company's London depots. He became deputy manager of the London sales department in 1956.

At the meeting of the Council of the London Chamber of Commerce on 12th May **Mr. A. L. Stock,** managing director of the Morgan Crucible Co., Ltd., was re-elected chairman.

Mr. S. E. Goodall has been appointed to the Council of the Association of Short-Circuit Testing Authorities, in succession to **Sir John Dalton,** who had retired and whose death is reported in our Obituary section. Mr. Goodall, who is President of the I.E.E. and director and chief engineer of W. T. Henley's Telegraph Works Co., Ltd., was responsible for the short-circuit testing station built by Henley's at Gravesend.

Mr. F. Walbank has been appointed manager of the Hendon district of Hoover, Ltd. He joined the company as a sales-service representative at Bradford in 1947. The previous manager, **Mr. J. Simpson,** has retired after thirty-three years' service and presentations were recently made to him on behalf of the directors and his colleagues.

Mr. G. Cooper, a divisional export manager of Hoover, Ltd., has recently completed twenty-five years' service with the company and has been presented with a gold watch by Mr. S. Roberts, managing director of Hoover, Ltd.

Mr. R. V. Fairey has been appointed London manager of G. P. Dennis, Ltd. Until recently he was the senior cable engineer in the London office of Johnson & Phillips, Ltd.

On 8th May Lord Mills, Minister of Power, made the presentation, on behalf of the Queen, of British Empire Medals to seven representatives of the electricity supply industry. The presentation was made at Lancaster House, St. James's, London, after which the recipients with their wives and friends were entertained by Sir Henry Self, chairman of the Electricity Council, at Winsley Street, London.

Furse Wholesale, Ltd., Nottingham, has appointed **Mr. R. March** as sales manager. He has been with the company for the past twenty-nine years and has been one of its Leicester office representatives for many years. He is vice-president and past hon. secretary of the Leicester Electrical Society. Mr. March will be working under Mr. T. C. Bond, the sales director.

Mr. R. March

The annual golf tournament of the Midlands Branch of the **Electrical Trades' Commercial Travellers' Association** was held on 6th May at Moor Hall Park, Sutton Coldfield. A meal was arranged in the club-house afterwards when the golf cup and prizes were presented by the chairman, Mr. T. C. Browne. The prizewinners were: First, Mr. J. Hinton; runner-up, Mr. S. C. Tutton; visitors' prize, Mr. A. R. A. Wood.

Mr. R. J. Jackson Nisbet, director of Canadian operations for Wolf Electric Tools, Ltd., is expected to arrive in this country on 27th May for a four weeks' business visit. The Canadian branch recently moved into new and larger premises at 93, Advance Road,

Sir Henry Self (front row, centre) with British Empire Medallists. With him in the front row are Messrs. H. E. Hoggard (North Eastern Electricity Board), R. Asher (East Midlands Division, C.E.G.B.), F. Stockton (North Western Electricity Board), and J. Darlington (North West, Merse side and North Wales Region, C.E.G.B.). Back row: Messrs. W. G. Brett (Southern Electricity Board), B. W. H. Turner (Eastern Electricity Board), and S. H. Whitehead (East Midlands Electricity Board)

Toronto, and Mr. Nisbet's consultations at the head office will include plans for the further development of the company's Canadian interests.

Dr. R. T. Parker has been appointed head of the Aluminium Laboratories, Ltd., Banbury and Geneva offices in succession to **Mr. R. D. Hamer.**

Dr. R. T. Parker

Dr. Parker, an Associate of the Royal School of Mines, joined the Aluminium, Ltd., group in 1938 and transferred to Aluminium Laboratories, Ltd., in 1946 as head of the Metallurgical Division. In 1950 he became director of research at the Banbury laboratories. He had previously been engaged in research with the British Non-Ferrous Metals Research Association. Dr. Parker is a Fellow of the Institution of Metallurgists and of the Royal Institute of Chemistry. For a number of years he has been chairman of the Aluminium and Magnesium Industry Committee of the B.N.F.M.R.A. and chairman of the Aluminium Development Association Research Committee, serving also on the Institute of Metals Publication Committee, B.N.F.M.R.A. Research Board and a number of Government metallurgical committees. He is a past-chairman of the Oxford Local Section of the Institute of Metals.

Mr. H. G. Bell, M.Sc.Tech., M.I.E.E., has joined R. W. Gregory & Partners as consultant. He recently retired from the position of chief engineer to the North Western Electricity Board.

Lord Chandos, chairman of Associated Electrical Industries, Ltd., recently inspected progress on the A.E.I.-Hotpoint Peterborough 110,000 sq ft factory extension to be completed this year. He was accompanied by **Mr. R. Craig Wood,** managing director, A.E.I.-Hotpoint, Ltd., who is also a director of Associated Electrical Industries, Ltd., and **Mr. S. P. Rudd,** works manager, Peterborough. The project is proceeding to schedule.

Mr. W. Crichton Vile, personnel officer of the South Wales Electricity Board, has been appointed hon. secretary of the South Wales and Monmouthshire Branch of the Electrical Industries Benevolent Association in succession to Mr. T. R. Hughes.

Mr. A. E. Sparrow has been appointed chairman of the Northampton Branch of the Association in succession to Mr. C. Binns and **Mr. W. J. Poole** succeeds Mr. Sparrow as secretary and treasurer of the Branch.

Mr. D. C. Billing, B.Sc.(Eng.), A.C.G.I., A.M.I.Mech.E., who writes in this issue on "Electric Refrigerators" (page 929), obtained his degree at the City and Guilds College where he studied from 1944 to 1947. He served as a commissioned officer in the R.A.F. until 1950 when he joined the Delco Remy & Hyatt Division of General Motors. In 1952 he was transferred to the Frigidaire Division of General Motors where he is at present employed as manager of the technical services section of the Engineering Department. He also lectures in mathematics and other engineering subjects at Willesden Technical College.

Mr. D. C. Billing

In the report of the **Cable Makers' Football Cup Competition** on page 867 of our 8th May issue, we referred to Southern United Telephone Cables, Ltd., as an associated company of W. T. Henley's Telegraph Works Co., Ltd. We are asked to make it clear that Southern United Telephone Cables is jointly owned by Henley's, British Insulated Callender's Cables, Ltd., and Enfield Cables, Ltd.

The North West (Manchester) area qualifying competition of the **Electrical Industries National Golf Championship** was held at the Stockport (Torkington) Golf Club on 6th May. Cards were taken out by 152 competitors and a number of non-playing friends gave their support to the meeting. The golf prizes were presented by various manufacturers and there were many other prizes. The winners were as follows:—Ferranti Trophy, Mr. R. G. Barclay; runners-up, Mr. J. D. M. Corser (Division 1) and Mr. B. C. Hore (Division 2); best gross, Messrs. F. Warren and C. C. Thirburn; veterans' prize, Mr. A. J. Armstrong; visitors' best net score, Mr. J. S. Banks; visitors' best gross, Mr. B. Harbottle; and putting, Mr. A. Goodwin. The 12-hole greensome competition in the afternoon was won by Messrs. H. Fletcher and J. S. Banks. The day's effort resulted in a sum of approximately £230 being raised for E.I.B.A. funds.

Mr. J. D. Beard, M.B.E., founder and former managing director of Beard Electrical, Ltd., has joined Ega Electric, Ltd., as assistant manager of the Egatube Division. He will be chiefly concerned with outside sales activities in the Midland counties in connection with the Egatube system of non-metallic electric conduit and fittings.

OBITUARY

Sir John Dalton.—It is with regret that we record the death, which occurred on 14th May, of Sir John Dalton, M.I.E.E., F.C.I.S., Barrister-at-Law, who was a well-known figure in the electrical industry, both on the electricity supply and the cable-making sides, for many years.

The late Sir John Dalton

Sir John, who was seventy-four, had spent most of his career in the electricity supply sphere. He was legal adviser to the former Electricity Commission from 1922 to 1927 and in the last-mentioned year began his long association with the County of London Electric Supply Co., of which (and of its associated companies) he became director and general manager. During the war years (1939 to 1945) he acted as Regional Controller of Fuel and Power for London and S.E. England and chairman of the Public Utilities Coal Committee, and he was knighted in 1942. In 1945 he was appointed a director of the London Power Co., and Central London Electricity, Ltd. Upon the nationalisation of the elec-

Lord Chandos (centre) with Mr. R. Craig Wood (right) and Mr. S. P. Rudd (left) inspecting progress on the erection of the A.E.I.-Hotpoint Peterborough factory extension

tricity supply industry in 1948 he relinquished this position and joined the Cable Makers' Association as director.

Sir John was appointed chairman of W. T. Henley's Telegraph Works Co., Ltd., in 1953 and held that position until June last year when he resigned from the chairmanship; he later retired from the board. He was chairman of Southern United Telephone Cables, Ltd., and was also on the board of Henley-Simplex Africa (Pty.), Ltd.

Sir John was president of the British Electrical Power Convention held at Torquay in 1956. He was editor of "Electricity Act, 1926," "Electricity Act, 1947," and of the fifth edition of "Electricity Law" (Will). He was president of the Electrical Industries Benevolent Association for 1953-54.

Mr. H. S. Butler, who died on 11th May at the age of seventy-six, was a director of Malcolm & Allan (London), Ltd., from 1927 until his retirement in 1948 when Malcolm & Allan became part of the Lancashire Dynamo Group.

Col. Sir Stanley Angwin. — A memorial service for the late Colonel Sir Stanley Angwin was held on 14th May at the Queen's Chapel of the Savoy. The Rev. Cyril Cresswell officiated. The lesson was read by Lord Reith and an address was given by Sir Gordon Radley (Director-General, G.P.O.). The service was attended by many well-known men representing various branches of the electrical industry, including the I.E.E., the Commonwealth Telecommunications Board, the G.P.O., B.E.A.M.A., and electrical manufacturing companies.

Mr. J. Ramsay. — The death occurred at Estoril, Portugal, on 11th May of Mr. James Ramsay, C.M.G., O.B.E., C.A., formerly general manager of the Lisbon Electric Tramways, Ltd., and president of the British Chamber of Commerce in Portugal.

WILLS

Mr. E. B. Allam, A.M.I.E.E., governing director of E. P. Allam & Co., Ltd., who died on 25th November last, left £81,405 gross (£73,341 net).

Mr. F. Grindrod, managing director of Hardman Co., Ltd., radio, television and electrical engineers, who died on 2nd February, 1958, left £40,075 gross (£39,785 net).

Mr. F. S. Johnson, formerly a director of the Ever Ready Co. (Great Britain), Ltd., who died on 8th September last, left estate in England valued at £32,706 gross (£32,521 net).

Mr. H. Evans, managing director of Unit Electrical Installation Co., Wednesfield, who died on 4th November last, left £13,621 gross (£4,969 net).

Mr. E. W. Steele, M.I.E.E., M.I.Mech.E., late director of the Metropolitan-Vickers Electrical Co, Ltd., Manchester, who died on 7th October last, left £33,788 gross (£33,664 net).

Mr. C. W. Cosgrove, B.Sc., M.I.E.E., formerly general manager of the Osram lamp and glass factories of the General Electric Co., Ltd., who died on 3rd November last, left £8,760 gross (£7,064 net).

Mr. F. A. Spence-Brown, joint managing director of Johnson, Matthey & Co., Ltd., who died on 29th September last, left £19,375 gross (£15,690 net).

Mr. J. D. Green, M.I.E.E., a founder of Green & Smith, Ltd., Leeds, who died on 11th October last, left £4,028 gross (£3,711 net).

Plastics Institute Regulations

The Council of the Plastics Institute has included in its revised regulations for the Associateship a new route, without examination, open to candidates holding suitable qualifications in appropriate basic subjects, who have acquired knowledge of plastics technology and science as a result of experience in the plastics industry. Copies of these regulations can be obtained from the Institute, 6, Mandeville Place, London, W.1.

A special course for teachers on the welding of plastics, sponsored by the Institute of Welding, the Plastics Institute and the British Plastics Federation will be held from 29th June to 10th July at the Borough Polytechnic, Borough Road, London, S.E.1. Particulars are available from the secretary at the Polytechnic.

The Trustees of the Plastics Industry Education Fund invite applications for training grants. Further particulars are obtainable from the secretary of the Plastics Institute.

G.E.C. Sales Area Reorganisation

As the first stage in the decentralisation of what has up to now been its London sales area, the General Electric Co., Ltd., has opened a new sales and distribution area office at Ealing covering the North London, Eastern and Southern Counties area, including the existing branches at Ipswich, Dagenham, Luton, Reading, Southampton and Bournemouth. The next stage will be the establishment of a new area office in South London which will cover the south and south-east of Central London. The Central London area office will be at Magnet House, Kingsway, London, W.C.2.

The new area headquarters, which was officially opened last Friday by the Mayor of Ealing, consists of a main building, with five floors, and several single-storeyed buildings which will be used for domestic equipment service workshops, conduit stores, the housing of bulk stores and a garage. There is also an all-electric staff canteen.

For the convenience of customers and to facilitate paper work, the trading departments are all on one floor. Orders are transferred by pneumatic tubes and a loudspeaking telephone enables the storekeepers to deal with requests from the order department without continually returning to the telephone. Special arrangements have also been made so that customers in the areas served by the Luton, Reading, and Dagenham branches will be able to speak to the new area headquarters via the telephone exchange at the branch.

Representatives of the company's heavy engineering group and of several subsidiaries including Woods of Colchester, Ltd., will be resident at the new establishment. Radio and television receiver sales will, however, continue to be handled by the radio division at Kingsway.

New G.E.C. sales and distribution area office at Ealing and (right) display of domestic equipment

INDUSTRIAL NEWS

Main-line Diesel-Electric Locomotives

The British Transport Commission has placed further orders valued at over £11 million for 130 main-line diesel-electric locomotives for British Railways. This brings the total number ordered for main-line duties in connection with the railway modernisation programme to more than 1,000. About 160 of the locomotives are already in service, and it is hoped that there will be nearly 500 by the end of this year. The 130 locomotives now ordered consist of 55 of 2,000 h.p. and 75 of 1,365 h.p. Both types, although varying in hauling capacity, will have a maximum speed of 90 m.p.h. The 2,000 h.p. Type 4 locomotives are to be built by the English Electric Co., Ltd., and the 1,365 h.p. Type 2 locomotives will be supplied by the Brush Electrical Engineering Co., Ltd.

Transformers for Indian Fertiliser Plant

The first fifteen of forty-seven English Electric transformers being supplied to Nangal Fertilisers and Chemicals (Private), Ltd., India, were loaded last week on the *Indian Pioneer* at Birkenhead. They will be installed at a fertiliser plant at Nangal in the Punjab to supply d.c. power for the electrolytic production of hydrogen and heavy water. The total power consumption of the project, the largest in India to be supplied by rectifier equipment, will be 170 MW. The English Electric contract to supply the complete electrical equipment for the plant is valued at about £1½ million. All the equipment is manufactured at the company's Stafford works. The first shipment consisted of three 35 MVA, three-phase, 50 c/s, 66/11 kV O.F.W. step-down transformers, six 4·5 MVA, three-phase, 50 c/s, 10,950/4,614 V O.F.W. regulating transformers, and six 10·75 MVA, 3-6-phase, 50 c/s, 11,000/782 V O.F.W. rectifier transformers.

English Electric transformers being shipped to India

Television Equipment for Brazil

Marconi's Wireless Telegraph Co., Ltd., has received an order valued at £250,000 from Brazil for television equipment. The order is for the complete transmitting and studio equipment for a new station at present under construction at Recife, Pernambuco, and was obtained for Marconi's by its agents in Brazil, Murray Simonsen S.A., and was placed by the Jornal do Comercio T.V. station, owned by Empresa Jornal do Comercio S.A., Recife.

Payment for Holidays

At a meeting of the Joint Industrial Council for the Electrical Cable Making Industry held on 12th May, the Council agreed that the additional payment for holidays agreement of May, 1958, should be amended by the substitution of 16⅔ per cent in place of 10 per cent in Clause 1 of that agreement. It was further decided that the amended agreement shall apply to all annual holidays taken in 1959 and in regard to statutory holidays shall commence with the payment made for Whit Monday.

Brookhirst Igranic European Subsidiary

The Metal Industries Group launched its first European subsidiary, Brookhirst Igranic (Europe) S.A., with a reception in Brussels on 13th May attended by the British Ambassador, Sir George Labouchere. A number of Belgian political leaders, financiers and industrialists were among the large gathering. Sir Charles Westlake, chairman of Metal Industries, Ltd., who welcomed the guests, said the advent of the Common Market, with the profound reorganisation which it would bring about, would necessitate new links between Europe's industrialists. Some companies in Britain were adopting a cautious policy towards these developments. Metal Industries, however, had decided that the time had come to take positive action. Sir Charles pointed out that the new company had two British and two Belgian directors. The administrative staff, engineers, clerks and workpeople were all Belgian nationals; in Holland all the staff were Dutch. Brookhirst Igranic (Europe) will look after sales and service of electrical control gear and other products manufactured at Chester and Bedford by the recently merged Brookhirst and Igranic companies.

Sir George Labouchere, British Ambassador to Belgium (left) chats with Sir Charles Westlake at the Brussels reception to launch the Brookhirst Igranic European subsidiary. In the centre is Mr. R. H. Frings, a Belgian director of Brookhirst Igranic (Europe)

Contract Price Formulæ

The British Electrical and Allied Manufacturers' Association has issued the figures for its contract price adjustment formulæ. In each case the rate of pay for adult male labour at 15th May is deemed to be 196s.

The "costs of materials" figures are: For electrical machinery and equipment the Board of Trade index figure published on 15th May is 180·3 (1949=100) and 116·2 (1954=100); both figures are provisional. For turbo-generating and allied plant: Materials used in mechanical engineering industries 187·7 (1949=100) and 124·9 (1954=100); both figures are provisional. Blast furnaces and iron and steel melting and rolling (40 and 41) 190·8 (1949=100) and other steel goods, excluding tubes (311 and 312) 130·0 (1954=100). The price of ⅝in o/d 18 s.w.g. brass condenser tubes (*Metal Bulletin*) is 47½d per lb.

Working Tramway Museum

The Tramway Museum Society is to establish a working tramway museum at Cliff Quarry, Crich, Derbyshire. The site is at the terminus of the mineral tramway belonging to the Clay Cross Co., Ltd., which has agreed to lease the site to the Society. It is planned to move to the site some of the tramcars the Society has in store in different parts of the country,

to provide covered accommodation for them and to construct a length of tramway track so that the trams may be operated. At the moment the Society owns trams from Southampton, Newcastle, Hull, Cardiff and Sheffield, and has been promised other cars. The hon. treasurer of the Society is Mr. G. Hyde, 412, King's Road, Higher Hurst, Ashton-under-Lyne, and the hon. publicity officer is Mr. D. Gill, 49, London Road, Hazel Grove, Ches.

Plessey Licensing Agreement

The Plessey Co., Ltd., announces that an agreement providing for the manufacture of "Metallux" resistors in the United Kingdom has been concluded with Elettronica Metal Lux s.p.a., Milan, Italy. Metallux metal film resistors have been available through Plessey as sole United Kingdom agents during the past 18 months. Under the new agreement, in addition to sole manufacturing rights in Britain, Plessey will hold selling rights for the United Kingdom and all Commonwealth countries. New equipment is to be installed and a separate production unit formed within the Capacitors and Resistors Division of the Plessey Co. at its Kembrey Street factory, Swindon, Wilts. Production is scheduled to start during the next few months.

Nigerian Company Registrations

A list of new companies registered in Nigeria, published in the *Nigeria Trade Journal*, includes Ward & Goldstone (West Africa), Ltd., Lagos, with a nominal capital of £100 and British Insulated Callender's Cables, Ltd., Lagos, also with a nominal capital of £100.

Chelsea Flower Show

For many years the Electrical Development Association's exhibit at the Chelsea Flower Show catered for the amateur gardener, but this year the Association's exhibit (26th-29th May) will be directed to the commercial grower. The electrical exhibit will occupy a larger site than in previous years and will include a 15ft × 25ft propagation house, a 9ft × 12ft greenhouse and a run of frames 5ft × 12ft. Electrical horticultural equipment for every type of grower will be on view and display material will explain how electrical methods and techniques save labour, improve efficiency, increase productivity and bring earlier cropping. Mechanical aids such as tillers, hedge trimmers, verge trimmers, long grass cutters and saws, and a small soil steriliser will also be shown.

Nickel Alloy Exhibition

An exhibition was held last week at Park Lane House, London, by Henry Wiggin & Co., Ltd., entitled "Wiggin Nickel Alloys in Industry." The aim of the exhibition was to help engineers and designers to make the best use of the alloys manufactured by the company. Part of the exhibition was devoted to a demonstration of the properties of these alloys, part to their fabrication and working and part to their application in industry. A large selection of nickel alloys, subassemblies and finished articles in which one or other of the Wiggin materials is incorporated was shown. The Wiggin nickel alloys fall roughly into four groups, corrosion-resistant alloys, heat-resisting alloys, electrical resistance alloys and materials with special physical properties. Examples were shown of their use in the aircraft industry for parts of gas turbines and the exhibition included a representation of the exhaust end of an aircraft gas turbine. There were also many examples of domestic and industrial electrical equipment containing Wiggin alloys.

Service Centre Competition

The Plymouth Service Centre of the South Western Electricity Board has won the Frank Forrest silver trophy for the brightest and most attractive display in large electricity service centres in the West Country. Bideford Service Centre won the display challenge cup for smaller service centres. During the past three weeks more than 100 electricity service centres throughout the South West from Bristol to Penzance have been competing to present two main themes in their displays. The windows have been presenting the value of electric refrigeration and the interior displays have shown a wide range of electric water heaters and small appliances.

Railway Bridge Floodlighting

To mark the centenary of the completion of the Royal Albert Bridge, Saltash, near Plymouth, designed by I. K. Brunel, which carries a single railway track across the River Tamar to link Devon and Cornwall, the bridge is now floodlit for the first time in colour, and the lighting will continue until 30th September next. The contract for the complete installation was awarded by British Railways (Western Region) to Pirelli-General Cable Works, Ltd., an associate of the General Electric Co., Ltd. The lighting system was designed by Mr. M. G. R. Smith, chief engineer, Western Region, in conjunction with the G.E.C. Lighting Division and incorporates 276 floodlighting units, 70 of them housing Osram tungsten lamps, 30 housing mercury lamps and 176 housing blue fluorescent tubes. To illuminate the underside of the support for the main spans of the bridge, forty-eight 1,000 W units are fixed at track level in opposite mounted pairs at 40ft spacings. The installation involved the supply by the Pirelli-General Cable Works, Ltd., of 3,350 yd of 7-core tough rubber sheathed cable and 160 yd of 3½-core paper-insulated lead covered, and single wire armoured, supply cable. The complete system was designed to the requirements of the chief mechanical and electrical engineer, Western Region, Mr. R. A. Smeddle, whose Plymouth works manager was responsible for the supervision of the installation, which was carried out by F. R. Madge & Sons, Ltd., Plymouth.

Russian Refrigeration Plant Order

Over 25,000 h.p. of Crompton Parkinson motors are included in the £1,000,000 Russian order recently received by the U.D. Engineering Co. for large-capacity refrigeration plants. Delivery of equipment will start before the end of this year and is due to be completed before the end of 1960. All the motors—over 22,000 h.p. of auto-synchronous power factor correction types and over 3,000 h.p. of induction types—are designed to suit the special requirements of the Russian installation. They will be manufactured in the Chelmsford Works of Crompton Parkinson, Ltd. Compressor equipment for the order is being supplied by James Howden & Co., Ltd.

Electric Vehicle Service Depot

Austin Crompton Parkinson Electric Vehicles, Ltd., recently moved its London service depot from Ladbroke Grove to Water Road, Abbey Estate, North Circular Road, Wembley, Middx. The premises, which were

The new London service depot of Austin Crompton Parkinson Electric Vehicles, Ltd.

formerly occupied by H.M. Stationery Office, have an area of 8,000 sq ft and in addition to service, maintenance, stores and trade counter facilities, provide office accommodation for the public relations and London area sales personnel.

Presentation to Witwatersrand University

The busts of Faraday, Watt and Rutherford by the South African sculptress Rhona Stern were in the B.E.A.M.A. exhibit in the new United Kingdom Pavilion which won the supreme gold medal at the 1959 Rand Easter Show. The Southern Africa Committee of the British Electrical & Allied Manufacturers' Association, which organised the exhibit, has presented the busts of these three electrical pioneers, and the relative models, to the University of Witwatersrand, for permanent display in the electrical engineering, mechanical engineering and physics departments.

Radio-Telephone Receivers for Canada

A contract for the supply of 350 Plessey radio-telephone receivers to the Canadian Department of Transport has been secured by Plessey International, Ltd., in the face of intense competition from both Canadian and American companies. Delivery of the receivers is already under way and they will be used for aeronautical and other services.

Floor Warming for Bears

An unusual Bristol resident to adopt floor warming is "Sebastian," the polar bear cub born at the Bristol Zoo. Although polar bears can withstand extreme cold they are susceptible to the wet English climate and to eliminate dampness and condensation in "Sebastian's" nursery, a B.I.C.C. "Panelec" heating system was embedded in the floor. A 500 W loading earth screened p.v.c. 210 V heating cable was laid on a ¼in cork mat, solidly embedded in a 3in concrete screed. The temperature was automatically controlled by a standard cartridge type thermostat inserted through a 1½in conduit in the floor, allowing easy removal for adjustment. The thermostat was set at 120 deg F to maintain a rise in temperature of 15 deg F within the enclosure, thus ensuring that the nursery remained dry at all times. "Sebastian" is the first polar bear cub ever to survive at Bristol, and the success of the installation can be judged by the fact that he lived, even though it was foggy soon after his birth, and cold, damp weather persisted for some weeks afterwards. British Insulated Callender's Cables, Ltd., manufactured and supplied the heating system which was installed by Rouch & Penny, Bristol, in consultation with Mr. R. E. Greed, director of the Bristol Zoo.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £180 0s 0d
COPPER, H.C. Electro	ton £234 10s 0d
Fire Refined 99·70%	ton £233 0s 0d
Fire Refined 99·50%	ton £232 0s 0d
COPPER Tubes ..	lb 2s 3½d
Sheet	ton £265 10s 0d
H.C. wire and strip ..	ton £286 15s 0d
LEAD, English ..	ton £71 10s 0d
Foreign	ton £70 0s 0d
MERCURY	flask £77 10s 0d
TIN, block (English) ..	ton £784 10s 0d
ZINC, G.O.B. Foreign	ton £78 5s 0d
BRASS Tubes (solid drawn)	lb 1s 10½d
Wire	lb 2s 7½d
PHOSPHOR BRONZE Wire	lb 4s 1d
PLATINUM	oz £28 10s 0d
RUBBER, No. 1 R.S.S. spot	lb 29½d—29¾d

Equipment in Corrosive Atmospheres

The April issue of the Fire Protection Association Journal contains a note on the various types of materials suitable for electrical apparatus and conductors for corrosive atmospheres in chemical works and chemical laboratories. Metal sheathed and armoured main cables, sub-circuit cables and flexible leads are dealt with, as are lighting fittings and other apparatus. The resistance of metals and other materials frequently used in electrical installations to the effects of such corrosive agents as sulphuric, hydrochloric and nitric acids, ammonia and caustic soda are shown. Copies of the journal are obtainable from the Association at Garrard House, 31-45, Gresham Street, London, E.C.2, price 4s.

Food-Mixer Design

One of the articles in the May issue of *Design* (Council of Industrial Design, 28, Haymarket, London, S.W.1, or through booksellers, price 3s) covers the subject of electric food mixers. The author, L. Bruce Archer, sets out to assess the place of the mixer in the home and then considers design from two aspects—appearance and convenience of use. The examples illustrated and described (sometimes very critically) are mainly of British manufacture but a few foreign designs are also shown and analysed. In the course of the article it is suggested that about 52,000 mixers valued at £1·3 million are sold annually. Export trade amounts to over £650,000, "mostly by Kenwood."

The same issue contains an article on some modern lighting fittings.

Oil Consumption in 1958

An increase of 25·3 per cent (to 31 million tons) occurred in oil consumption in the United Kingdom in 1958. Of the total, fuel oil consumption represented over 13 million tons (against 9 million tons in 1957). Public electricity generation is credited with a consumption of 2·6 million tons as compared with only 0·6 million tons in the preceding year. The electricity supply industry also used 62,232 tons of oil in stationary oil engines (against 55,173 tons in 1957).

Works Visit

A party of thirty-four electrical contractors from Southern England recently visited the Ekco Works, Southend-on-Sea, of E. K. Cole, Ltd. The visit was arranged by Ford Wholesale Electric, Ltd., Eastbourne,

A party of electrical contractors at the Southend-on-Sea works of E. K. Cole, Ltd. Mr. J. E. Woodward (Ekco domestic sales supervisor) is fourth from the right in the front row, and Mr. T. H. Atkinson (Ekco heating sales representative) is seventh from the right, front row

and the contractors were welcomed by Mr. J. E. Woodward, domestic sales supervisor, and Mr. T. H. Atkinson, heating sales representative.

Imperial College Telephone Exchange

As part of the expansion programme for the Imperial College of Science and Technology, a new internal telephone exchange with a capacity of up to 2,000 lines is to be installed by the private telephone division of Siemens Edison Swan, Ltd. The new exchange will replace an earlier one of 800 lines provided by the same company.

New Display Cards

Two new display cards for tubular bars for electric fires have been produced by Metway Electrical Industries, Ltd., Metway Works, Canning Street, Brighton, 7. One card covers six standard sizes of milled nut fixing type tubular bars and costs 36s 2d. The other covers three sizes of tubular bar which have extendable end caps and the cost is 20s 2d.

Boiler Feed Pump Motors

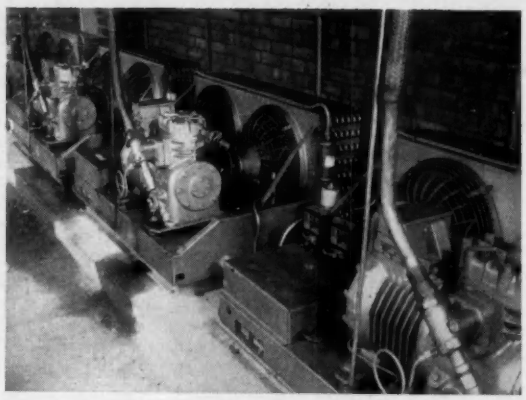
The General Electric Co., Ltd., is to supply boiler feed pump motors valued at over £289,000 for the Central Electricity Generating Board's Thorpe Marsh and Blyth "B" power stations. Believed to be the largest 2-pole variable speed slip-ring motors to be built in this country, each of the two motors for the starting and standby pumps at Thorpe Marsh is rated at 7,900 h.p., speed variation being obtained through motor-operated liquid controllers. Also at Thorpe Marsh, three 3,550 h.p. 2,980 r.p.m. squirrel cage motors have been ordered for driving the booster pumps. The pumps for this station are being built by G. & J. Weir, Ltd. Four 4,000 h.p. slip-ring motors with liquid controllers to give a speed range of 1,480-1,110 r.p.m. and six 1,750 h.p. squirrel cage motors are being supplied for driving the boiler feed pumps and booster pumps at Blyth "B" power station, the pump makers being Hathorn Davey & Co., Ltd. All the motors for both stations will be of the totally enclosed water-cooled type, designed to operate on an 11 kV supply.

Annual Holidays

The various works of British Insulated Callender's Cables, Ltd., will be closed for the annual holidays as follows:—Erith, Helsby, Huyton Quarry, Melling and Prescot, from 18th July to 3rd August; Anchor Works, Leigh, from 4th to 11th July and 12th to 19th September; Willenhall Foundry, from 25th July to 8th August; all dates inclusive.

Frozen Food Store

William Kingham & Sons, wholesale and provision merchants and equipment suppliers, Reading, have recently completed a frozen food store with a capacity of about 7,650 cu ft. It is designed to hold nine tons of frozen foods. The refrigeration equipment, which was supplied by the Southern Electricity Board, Reading, consists of four "Prestcold" 3 h.p. condensing units which operate four ceiling - mounted forced - air unit coolers. The "Defrostermatic" automatic defrosting system is controlled by two time switches, which ensure that only two of the units defrost at a time so that the required temperature in the store is maintained throughout the whole operation.



"Prestcold" condensing units in a Reading cold store

TV Tube Guarantee

Siemens Edison Swan, Ltd., announces that from 1st June all new Ediswan Mazda cathode ray tubes will be covered by a 12-month guarantee instead of the 6-month guarantee which has previously operated.

Medical Electronics Conference

The 2nd International Conference on Medical Electronics will be held from 24th to 27th June at the new UNESCO building in Paris.

Instrumentation and Automation

The International Congress and Exhibition for Instrumentation and Automation, last held in 1957, will be repeated next year from 19th to 26th October, in Düsseldorf.

Trade Announcements

The head office of **S.L.R. Electric, Ltd.**, is now at 2, Peterborough Road, Harrow, Middlesex. The address of the factory and stores is unchanged.

George Cohen, Sons & Co., Ltd., have been appointed by **John Barnsley & Sons, Ltd.**, of Netherton, Worcs., as sole agents in Scotland, Ireland and South Wales for the Barnsley range of electric overhead travelling and Goliath cranes.

W. H. Allen, Sons & Co., Ltd., Bedford, who have recently established their own branch office in Scotland, are transferring the branch on 25th May to new premises at 234, St. Vincent Street, Glasgow, C.2 (telephone: Central 5906/7). The company's complete representation and service arrangements for the whole of Scotland will be handled from the new Glasgow office, under the management of Mr. H. Winter.

Alfred Graham & Co., Ltd., a subsidiary of **Siemens Edison Swan, Ltd.**, has undertaken from 1st April to carry out all sales of convection heaters and tubular heaters hitherto handled by Siemens Edison Swan, Ltd. Alfred Graham & Co., Ltd., manufactures this equipment and will now also conduct its own sales campaign independently. Orders and inquiries should be addressed to the company at Washer Lane, Halifax, Yorks. (telephone: Halifax 61656).

Polypenco, Ltd., has appointed the Norman Wrigley Co., Ltd., 366, Stretford Road, Manchester, 15, as its agents for North West England, and Durward Clarkson & Co., Ltd., 137a, St. Vincent Street, Glasgow, C.2, as its agents for Scotland.

The Publicity and Accounts Departments of the **Cambridge Instrument Co., Ltd.**, which have hitherto been at Universal House, Buckingham Palace Road, S.W., have now returned to the company's head office at 13, Grosvenor Place, London, S.W.1 (telephone: Belgravia 5066), which has been enlarged.

As from tomorrow (Saturday), the telephone number of the Middlesbrough branch of **British Insulated Callender's Cables, Ltd.**, will be Middlesbrough 3974/5.

Automatic Control in Russia

Last week-end a British team of experts in automatic control left the United Kingdom to study the developments and applications of automatic control techniques in industry in the U.S.S.R. This visit, which will last for two weeks, has been arranged as a result of collaboration between the Institution of Electrical Engineers and the British Council on the one hand and the Academy of Science of the U.S.S.R. on the other, and reciprocates a visit to this country at the end of last year by a Russian team.

The British team, whose individual interests are indicated in parentheses, will consist of the following six members:—Professor A. Tustin (academic), who is also the leader; Mr. A. Asbury (industrial applications); Mr. S. S. Carlisle (iron and steel research); Mr. P. H. Hammond (control mechanisms); Mr. R. H. Tizard (consultant); and Mr. A. J. Young (chemical industry).

PARLIAMENTARY REPORT

Scottish Pumped Storage Scheme

Fears that the North of Scotland Hydro-Electric Board's Loch Awe scheme would damage the beauty and amenities of the Western Highlands were expressed by Lord Chorley and others in the House of Lords last week. The section Lord Chorley complained of was the pumped storage part at Ben Cruachan. The scheme was highly objectionable, he contended, because it entailed building a new reservoir in the finest corrie in Cruachan. As water was let out of the reservoir by day, mud and rock would be exposed, creating a desolate picture. The total saving by this sort of scheme was very small indeed, he said. Even at the best of times these hydro-electric schemes were not especially fruitful; the total production of all the schemes was only about 2 per cent of the electricity that was produced in the British Isles.

Lord Ferrier said that if the scheme was economically necessary, some measure of interference with national beauty must be faced. He sometimes worried lest the Electricity Boards charged too much for their off-peak load. If only they would face up to the need for supplying off-peak loads at lower tariffs, then perhaps energy which otherwise would be wasted, if it was not pumped up to Ben Cruachan, could be sold for pit-pumping, space heating and the like, thus avoiding the necessity for a scheme of this kind.

Lord Strathclyde said in recent years he had visited many of the schemes of the Hydro-Electric Board and he had yet to find one that was detrimental to the scenery; in many cases they had been beneficial to it.

Lord Forbes, Minister of State, Scottish Office, replying, said he could not follow Lord Chorley when he said the Loch Awe scheme, which was going to produce 12 per cent of Scotland's electricity, was a small scheme. The Cruachan part would produce 400 million units a year, the Nant part 27 million, and the Inverawe 100 million. In the North of Scotland hydro-electric generation provided 80 per cent of the electricity used and at the same time it produced electricity more cheaply than by other means.

The Scottish Boards expected that by the end of 1964 the peak demand would be some 69 per cent more than in 1957, and would total 3,250 MW of which the Awe scheme would supply 450 MW, i.e. 12 per cent of the total Scottish demand, or 34 per cent of the additional capacity that the Boards expected they would have to provide in the next five years. The pumped storage part of the scheme was estimated to show a saving of 0·2d per unit over the cost of production for the same load factor by a new steam station. The conventional hydro-electric part of the scheme showed a saving of 0·4d per unit compared with costs at a steam station. A special committee existed for dealing with amenity questions and no objections on amenity grounds had been received in the case of the Loch Awe hydro-electric scheme.

Lord Forbes concluded by paying a warm tribute to the chairman of the North of Scotland Hydro-Electric Board, Mr. Thomas Johnston, who is to retire from office after 13 years' service. Under his chairmanship, he said, the Board had acquired a high reputation, not the least for the care it had taken to preserve amenities.

Space Research

Making his statement on British plans for space research, the Prime Minister said that with the assistance of the Fellows of the Royal Society and with the endorsement of the Advisory Council on Scientific Policy, a programme for the design and construction of instruments to be carried in earth satellites had been approved. Work would begin at once. A team of experts was being sent to Washington to discuss possible Anglo-American co-operation and consultations were also being opened with Commonwealth countries. Meanwhile the adaptation of British military rockets was being studied and this would put us in a position, should we decide to do so, to make an all-British effort. The instrument programme would be supervised by the British National Committee on Space Research set up by the Royal Society under the chairmanship of Professor Massey.

Protection of Industrial Designs

The Parliamentary Secretary to the Board of Trade, Mr. J. Rodgers, M.P., announced in the House of Commons on 14th May that the President of the Board of Trade had appointed a Departmental Committee to review the law relating to the protection of industrial designs. The chairman of the Committee is Mr. K. Johnson, Q.C., and the members include Mr. G. Grant, C.B., Comptroller General of Patents, Designs and Trade Marks. The Committee's terms of reference are:—"To consider and report whether any, and if so what, changes are desirable in the law relating to the protection of industrial designs. In framing their recommendations the Committee should include consideration of the desirability of enabling United Kingdom designs to receive cheap and effective protection in other countries on the basis of reciprocity."

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged.

MONDAY, 25th MAY

Ipswich.—Electric House, 7.15 p.m. Ipswich and District Electrical Association. Annual general meeting.

MONDAY, 25th MAY to SATURDAY, 30th MAY

London.—Olympia. International Hospital Equipment and Medical Services Exhibition.

MONDAY, 25th MAY to THURSDAY, 4th JUNE

London.—Olympia. Business Efficiency Exhibition.

TUESDAY, 26th MAY

Birmingham.—Birmingham Electric Club. Visit to Berkeley nuclear power station.

WEDNESDAY, 27th MAY

Edinburgh.—Carlton Hotel, North Bridge, 7 p.m. I.E.E. Scottish Centre. Annual general meeting, followed by "The Automatic Digital Recording of Experimental Values," by W. H. P. Leslie.

THURSDAY, 28th MAY

Croydon.—Greyhound Hotel, 7.15 p.m. A.S.E.E. South London Branch. Annual general meeting, followed by branch lecturettes.

Hampton.—Fulwell Golf Club. A.S.E.E. Golfing Society. Play for Tanjon Trophy.

Hove.—New Imperial Hotel, First Avenue, 6.45 p.m. A.S.E.E. Brighton, Hove and District Branch. Annual general meeting, followed by "Lighting and Colour."

London.—Connaught Rooms, W.C.2, 12.30 for 12.55 p.m. Batti-Wallahs' Society. Luncheon. Guest speaker, Mr. W. C. Thorpe.

17, Belgrave Square, S.W.1, 6.30 p.m. Institute of Metals. "The Atomic Mechanisms of Fracture," by Professor N. J. Petch.

FRIDAY, 29th MAY and SATURDAY, 30th MAY

Peebles.—I.E.S. Edinburgh, Glasgow and Newcastle-upon-Tyne Centres. Jubilee Regional Conference at Peebles.

FRIDAY, 29th MAY to SUNDAY, 31st MAY

Southport.—I.E.S. Liverpool and Manchester Centres. Jubilee Regional Conference.

SATURDAY, 30th MAY

Wolverhampton.—Chamber of Commerce, Lichfield Street, 7 p.m. A.S.E.E. Wolverhampton and District Branch. Annual general meeting.

"Plastics Review"

The 1959 edition of "Plastics Review," issued by Bakelite, Ltd., deals with some of the current applications of Bakelite plastics, both in industry and in the home, and includes a description of the use of Bakelite polyester and epoxide resins at Harwell. The "Review" is well produced with many illustrations in colour.

Engineering in Europe

ABSTRACTS FROM FOREIGN TECHNICAL JOURNALS

HEAT transfer coefficients of internal cooling may be determined accurately in a comparatively simple way in the case of a turbulent flow. The determination is slightly more involved for a laminar flow, and it is very uncertain for a mixed flow in the transition zone. If the conductor temperature is assumed to remain constant, either this temperature or, alternatively, the permissible current density in the conductor can be calculated easily.

For a given pressure drop there exists an optimum rectangular duct section. The accurate solution of the problem of the heat flow in the conductor is laborious, and the author therefore presents a solution valid for a limited range, not considering the effect of the temperature coefficient of the conductor material.—" Fundamental Equations of Internal Cooling," *E.T.Z.(A)*, Vol. 80, No. 2, pp. 44-52, 11th January, 1959, in German.

Stator Windings of Large Machines

A comprehensive investigation was carried out in the All-Union Electrical Research Institute on the deformation and vibration of the insulation of large electric machine stator windings, more particularly of hydro-generators and synchronous motors. The measurements were carried out with strain gauges and an amplifier equipment designed for the purpose, and also by high-speed cinematographic methods.

The vibrations are mainly at frequencies of 100 and 50 c/s and both deformation and vibration are approximately proportional to the square of the stator current. All the operating conditions of alternators, viz. starting, parallel operation, accurate and self-synchronisation, load shedding, asynchronous operation with excitation, three-phase and two-phase short circuits, with and without earthed neutral, were investigated. It was found that the deformation of the insulation and the vibration of the end connections of the stator windings under all the conditions of operation of hydro-generators are negligible; they are lower or of the same order as those set up in synchronous motors started across the line. These investigations should be carried on and extended to include turbo-generators.—"Experimental Determination of the Deformations and Vibrations of Stator Windings," M. F. Yudov, *Elektrichestvo*, No. 12, pp. 39-43, 1958, in Russian.

Convertor Recovery Voltage

The methods of calculating the recovery voltage in convertor installations so far published are very complicated, not sufficiently clear and can only be applied to the simplest rectifier circuits. The author presents a very simple method, based on equivalent circuits, which enables the frequency and damping of the recovery voltage to be determined very quickly.

For more complicated installations it is preferable to determine the recovery voltage by oscillograph in a special arrangement on an equivalent circuit of simple construction, in which oscillations are set up. These methods were tested on some existing installations, including an experimental d.c. transmission line. The agreement between the results obtained by this method and measurements on the operating plants was satisfactory. It was found that in large-scale plants the oscillations are damped by losses not usually considered in calculations. — " Determination of the Form of the Recovery Voltage in Convertor Installations," N. M. Maslennikov, *Elektrichestvo*, No. 12, pp. 9-13, 1958, in Russian.

Induction Furnaces

Low-frequency induction furnaces have been increasingly used owing to their simple design, for various purposes, and of late even for melting down large charges of metal. The type most frequently used has an iron core and a submerged melting channel. The electrodynamic phenomena in the melt are rather complicated in these furnaces. However, it is shown that the most important phenomena in this respect, viz. the contraction and eddy phenomena in a melting channel of rectangular cross-section, can be analysed by a relatively simple mathematical method.

It is possible to determine the critical current density up to which there are no contraction phenomena and the flow conditions in the melting channel, which is necessary for a correct design of the latter. The analysis applies to melting channels of modern furnaces with a large collecting tank for the molten metal, which may be supplied by several furnace units with a submerged melting channel. A Czechoslovakian design of such a furnace with three melting units is shown.—" Electromagnetic Phenomena in the Melting Channel of Low-Frequency Induction Furnaces, with Iron Core," Z. Ryska, *Elektrotech. Obzor*, Vol. 43, No. 3, pp. 123-128, 1959, in Czech.

Electromagnetic Pump

It has been shown that the conditions in the pump with respect to armature reaction can be characterised by three dimensionless parameters. The relationships between these parameters which have to be satisfied in a pump without compensation for certain optimum or critical conditions, such as maximum efficiency, or maximum pressure, etc., to be achieved, were derived. Apart from this, the maximum pressure attainable with such a pump, considering supersaturation of the magnetic circuit, was estimated. For a pump compensated by a return conductor led through the air gap the compensation is conditional on equal current distribution in the pump and the compensating conductor. For a pump compensated by an enlarged air gap, the corresponding condition is expressed as a relationship between the ampere-turns of the exciting winding, the total current sent through the pump and the circuit connections to the pump.

The maximum pressure in this type of pump, considering supersaturation of the magnetic circuit, cannot be higher than twice the pressure in a pump without

Readers who require accurate full translations of any of the articles abstracted in this section can be put into touch with the translators who will supply them at current rates.—Editors, *Electrical Review*.

compensation. A special section of the paper deals with the effect of the layout of the connections to the piping of the pump on the magnetic field in the latter. Experiments were carried out to confirm the results of the calculations.—" The Armature Reaction of an Electromagnetic D.C. Pump for Liquid Metals," I. Hla'snik, *Elektrotech. Obzor*, Vol. 43, No. 3, pp. 135-146, 1959, in Slovakian.

Starting D.C. Drives

There is a tendency nowadays to dispense, so far as possible, with tests of d.c. drive starting processes and to determine the starting processes analytically. For separately excited d.c. motors this leads, with some permissible simplifications, to a system of two first-order differential equations with variable coefficients. Even in the comparatively simple case of an exponential flux variation, this produces a second-order differential equation with variable coefficients, to be solved for three points, which is not possible by any known, even special, functions.

The calculations are considerably simplified if the armature inductance is disregarded. The solving processes are then convergent, if the coefficients are small. Only the errors of the approximate solutions obtained have then to be estimated, before the method can be used for practical calculations. The solving processes and the errors introduced by them are considered.—" The Problem of the Calculation of the Starting Processes in Electric Drives with D.C. Motors," Yu. N. Bakaev and P. I. Kuznetsov, *Elektrichestvo*, No. 3, pp. 47-50, 1959, in Russian.

High-Voltage D.C. Switchgear

Switchgear for use on h.v. d.c. lines must be capable of clearing currents of 1,000 to 1,500 A at voltages of 600 to 1,200 kV within not more than 0·03 sec. The only principle that can be used effectively for this purpose is the variation of the curve form of the current by shunting the arc with an oscillating circuit and then to use for circuit-breaking the methods used for h.v. a.c. circuit-breaking. Switchgear based on this principle was developed by the Leningrad Polytechnical Institute jointly with the D.C. Research Institute.

The theory of this type of circuit-breaker is explained and the design of the fully successful experimental breaker is described. The type of breaker most suitable for this purpose is an air-blast breaker whose contacts remain open after the clearance. It is not necessary to charge the capacitance of the oscillatory circuit if the circuit parameters and the arc characteristic of the breaker are correctly matched; a special discharge device for the capacitor bank, interlocked with the circuit-breaker, should be used. Oscillograms of the clearances are included in the article.—" Switchgear for High-Voltage D.C. Transmission Lines," G. A. Kukekov, P. G. Sorokin and N. A. Shipulina, *Elektrichestvo*, No. 3, pp. 24-27, 1959, in Russian.

Thermal Stability of Insulants

The author's method of determining the thermal stability of moulded parts, enamelled wires and motors by transforming their service-life curves into " life-time number curves " is demonstrated by giving examples of ageing tests on these products, the method being graphical and analytical. The choice of the life-time number Z_d is explained and the various factors, criteria and methods of evaluating the results of tests of the continuous thermal stability are compared. For some coils the ageing curves based on weight loss and tan-δ measurements are similar. The ageing curves based on impact bending and on the electric breakdown gradient were used to draw life curves based on the criteria 1 kg cm/cm^2 and 5 kV/mm, respectively, and these curves were then transformed into life-time number curves; the slope of the latter represents the " thermal factor." With correctly chosen Z_d, linear (or sometimes non-linear) relations $\log Z_\theta = f(\theta)$ then represent the permanent thermal stability of the materials considered.

The permissible service temperature θ_{max} can thus be calculated or determined graphically. For example, the insulation of model coils tested in this way showed that the conversion factor between the life of the enamel wire and the coil was 50, which also referred to the life of actual motors in continuous operation in the laboratory, whereas for motors in actual service it would be 200. The choice of Z_d depends in the main on these conversion factors between life times in the laboratory and in actual service, but the combined ageing tests now usual give useful indications for the correct choice of these factors.—" Determination of the Thermal Stability of Insulating Materials and Systems," L. Kolar, *Elektrotech. Obzor*, Vol. 47, No. 11, pp. 583-592, 1958, in Slovakian.

Circuit-Breaker Testing

Tests of the breaking capacity of circuit-breakers require a high degree of synchronism and accuracy in the time sequence of the various operations, which could not be strictly achieved with the control elements usually employed, viz. " automatic " drum controllers driven by motors, or relay circuits (often electronic relays). The solution of this problem, by combining a "chronometric" mechanism, counting in half-periods of the operating frequency, with phase-selector devices and null indicators, is described and the actual apparatus based on the principle outlined is discussed and illustrated.

The equipment was developed and tested in the All-Union Electrotechnical Laboratory in whose Breaker Testing Laboratory it is now used for controlling circuit-breaker tests in a synthetic circuit with a high-power surge generator. The supply frequency is divided gradually down to one-sixteenth of the original frequency, to obtain the required pulses of various lengths.—" An Apparatus for the Automatic Control of the Tests in Laboratories of the Breaking Capacities of Circuit-Breakers," N. M. Chernyshev and A. M. Arzyaev, *Elektrichestvo*, No. 3, pp. 50-55, 1959, in Russian.

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Industrial Research

D.S.I.R. SECOND FIVE-YEAR PLAN

THE annual report of the Research Council of the Department of Scientific and Industrial Research for the year 1958 (Cmnd. 739, H.M. Stationery Office, price 3s 6d) is largely a policy document dealing with the second five-year plan (1959-1964) and reviewing the various research stations of the Department. The report outlines how much change should take place in the Department by 1964 and how this change should be accomplished.

The second five-year plan will involve an increase in expenditure of some 70 per cent, and it is considered that this increase, which will occur as more qualified manpower becomes available, should not be allocated too closely in advance to specific projects. Proposals for the support of industrial research and development will be considered by the Council, and it is expected that an expansion of the information and advisory services will take place to ensure that research results are more widely known and applied. The number of grants for research and post-graduate training in universities and other educational institutions will increase and the total number of studentships will double during this period. Grants for special researches will also be increased in both number and duration. Promising lines of research for which the universities cannot make adequate provision may receive support for periods up to 17 years.

The programme includes the provision of new buildings at Crowthorne, Berkshire, to house the road research laboratory, and the adaptation of buildings at Thorp Arch, near Leeds, for the National Lending Library for Science and Technology, in addition to extensions to most other stations. A total expenditure of £61 million is entailed in the 1959-1964 programme, compared with £36 million in the previous five-year plan. The gross expenditure should rise fairly uniformly from about £9 million for the current year to £14 million in 1963-1964.

Research Stations

Apart from the new five-year plan, the Council has continued its thorough review of the Department's activities which started in 1957. There is a growing field for research appropriate to the various research stations, demanding a careful selection of the most important projects and a concentration of the available resources on them. The Electricity, Metrology and Physics Divisions, and the Test House at the National Physical Laboratory have been reorganised on a functional, instead of a subject, basis in three divisions dealing with fundamental standards, basic physics and applied physics.

A change of name has taken place at one station, the Chemical Research Laboratory now being called the National Chemical Laboratory, since it exists not to cover the whole field of chemistry research but to undertake selected researches of national importance. By concentrating on fewer projects at the Mechanical Engineering Research Laboratory, in addition to expanding the laboratory's resources, the Council hopes to achieve more rapid progress on those items that offer the probability of the largest dividends. The new laboratory at Stevenage announced by the Council last year, replacing the Fuel Research Station at Greenwich, has been named the Warren Spring Laboratory. Work on atmospheric pollution research, however, is expected to continue at Greenwich until the end of this year.

Responsibility for the Tropical Products Institute was transferred on 1st April of this year from the Secretary of State for the Colonies to the Lord President of the Council, and the Institute then became a research station of the Department. Steering committees, advising on the work of the stations, have been set up for the Warren Spring Laboratory, the National Chemical Laboratory, the Torry Research Station, the Forest Products Research Laboratory and the Mechanical Engineering Research Laboratory. A new scale of charges for work on a repayment basis has been introduced varying between stations and depending on the amount of equipment possessed by them. Answers to inquiries requiring no research work have in the past been provided free of charge, and in general this practice will be maintained.

Grant-Aided Associations

The report continues with a review of grants for both post-graduate training and research, and a survey by the Industrial Grants Committee of the value of the work carried out by grant-aided research associations. It is thought by the Council that these associations should be encouraged to do a certain amount of sponsored research, provided the co-operative research programmes do not suffer. Plans have been approved to bring the new National Lending Library into operation by 1962. Small grants have been made during the year to regional organisations for supporting or extending information services based on Bristol, Cardiff, Manchester and Newcastle for communicating information to small- and medium-sized firms employing few scientists and technologists. Finally, the growing needs of the Overseas Liaison Division arising from its duty of reporting on foreign developments in science and technology are discussed, and the report concludes with appendices giving details of the Department and its work.

Aircraft Invertors

A NEW British Standard in the aircraft series, B.S. G.174: 1959, specifies the general design and test procedure for apparatus to derive an alternating current at controlled voltage and frequency from an aircraft d.c. electrical supply. The specification aims to provide for invertors for general use on aircraft and also, where practicable, for those suitable for aircraft applications requiring a more closely controlled output. The performance and test requirements, therefore, are appropriately differentiated for general purposes and for special purpose machines, and also according to the altitude for which the invertors are suited. Some of the performance requirements for special purpose invertors are a compromise between the needs of applications requiring different degrees of accuracy, resulting from the varied uses of the invertors and from the penalties of weight and size likely to be involved in achieving a very closely controlled output.

Copies of this standard may be obtained from the British Standards Institution, Sales Branch, 2, Park Street, London, W.1. Price 10s.

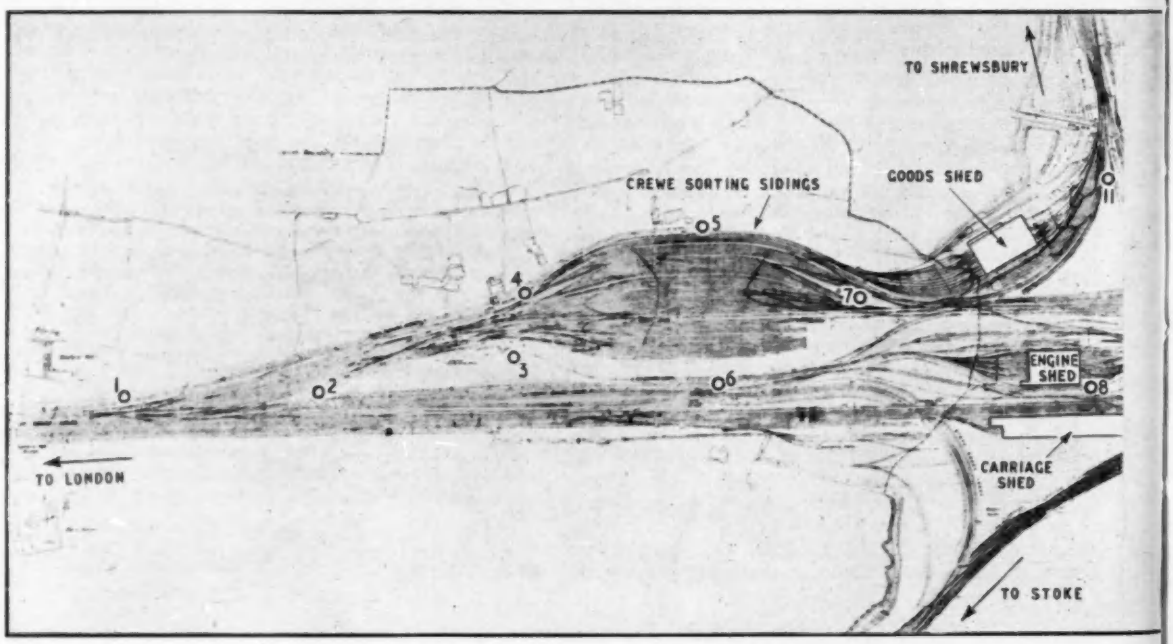
HIGH TOWER LIGHTING

Above: Seven of the twelve towers are visible in this view looking over the sorting sidings to the engine sheds and Crewe station. Right: The sorting sidings at night. A higher level of illumination has been provided at the points in the foreground

A FLOODLIGHTING installation, illuminating an area of over half-a-million square yards of main lines, marshalling yard and sidings, including the road and rail approaches to the engine, carriage and goods sheds, was recently commissioned at Crewe by the London Midland Region of British Railways. It replaces several hundred lamp standards removed to permit the installation of overhead electric traction equipment. The junction at Crewe is one of the busiest in the country, some 5,500 wagons being handled daily in the marshalling yard alone, and the installation will provide an extra factor of safety for the railway employees in addition to assisting shunters and enginemen to locate trucks and read destination labels.

The illumination level required by the British Transport Commission varied, according to the operating function of the area concerned, between 0·15 and 0·5 lumens/sq ft, and to achieve this twelve 150ft high towers, each supporting a number of 1,500 W tungsten filament g.l.s. lamps in weatherproof floodlighting fittings,

The twelve tower positions are shown on the track layout plan

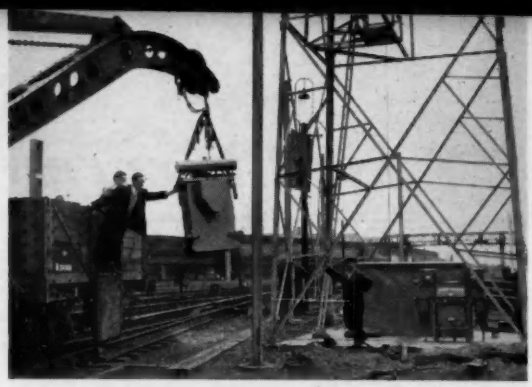


were erected at intervals of up to 300 yd throughout the site. The lighting scheme was designed to the requirements of British Railway engineers by the A.E.I. Lamp & Lighting Co., Ltd., using a spherical chart technique, and the results were checked by a point-by-point calculation with a digital computer. Of the 187 No. M25 fittings 103 are of the specular and 84 of the diffuser type, giving a total lighting load of 280·5 kW. These fittings were slightly modified, enabling them to be turned through 180 deg for cleaning and maintenance and returned to pre-set stops without needing re-alignment and re-focusing.

Power for the installation is obtained at 6·6 kV from two existing railway substations, joined by a distribution loop of approximately 7,000 yd of 0·04 three-core p.i.l.c.s.w.a. and s. cable of Siemens Edison Swan manufacture. This loop is connected at each tower by a J. G. Statter weatherproof type VL/2-OD ring main unit to an English Electric 50 kVA, 6,600/415 V oil-filled outdoor transformer. The output of this transformer is taken to a weatherproof switch panel manufactured at the Paisley works of James Kilpatrick & Son, Ltd., and consisting of Allen West type S.C.N. contactors with English Electric isolators and distribution fuse-boards. The contactors in the supply to the fuse-boards are operated through multi-core p.i.l.c.s.w.a. and s. cables by 15 A switches installed remotely in two signal boxes and a shunter's cabin, enabling the lighting required to be selected from the control point for the tracks and train operations.

From the switch panel a further lead-covered and armoured cable is taken to the top of the tower, held in position by B.I.C.C. claw-type cleats. Particular attention has been paid to supporting these cables in the towers to prevent strain due to the considerable vertical length of the cable run. At the top of the tower a weatherproof cubicle housing English Electric fuse-boards and isolators is installed, and each lighting fitting is connected through a watertight switch socket outlet and v.r.i. cable enclosed in galvanised solid drawn conduit to a separate way on the fuse-board.

The galvanised steel lattice towers, which were designed and erected by the British Insulated Callender's



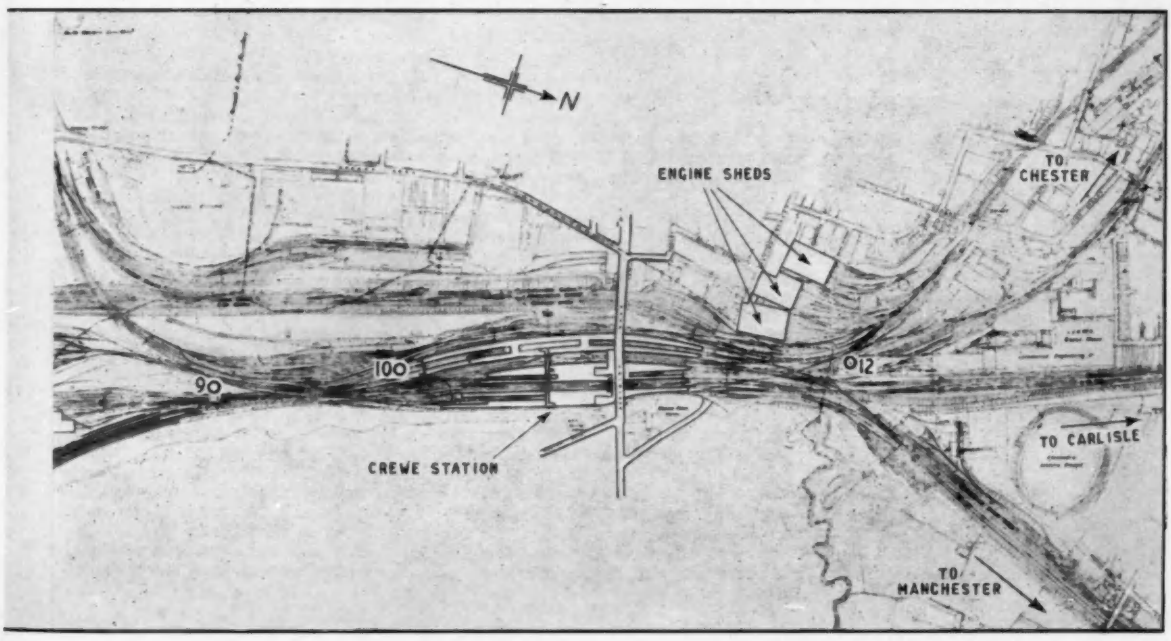
Placing a 50 kVA transformer in position at the base of a tower, showing the close proximity of the towers to the tracks

Construction Co., Ltd., each weigh 10 tons 6 cwt and are mounted on concrete bases approximately 9ft deep and 3ft square at the four legs of each tower. Since space at the tower sites between the tracks was limited, the concrete was mixed on a special train and poured directly into the prepared foundations. At the top of each tower is a lifting jib and a platform 13ft square on which is mounted the supporting framework for the lighting fittings and distribution cubicle. Ten of the fittings can be installed on each of the four sides of the platform.

Owing to the made-up nature of the ground and the subsidence, running sand and spring water that were encountered, difficulties were experienced in consolidating the tower foundations, and these conditions also made difficult the earthing of the neutral point of the transformer secondary and the tower steelwork for lightning protection.

Close liaison was maintained between the contractors and the railway operating staff as all materials and equipment had to be transported to site by rail, there being no road access, in addition to the necessary co-operation with the London Midland Region engineering departments, while particular consideration had to be given to the proposed overhead railway electrification scheme scheduled for this area.

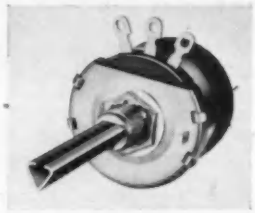
The main contractors for the installation were James Kilpatrick & Son, Ltd.



NEW ELECTRICAL EQUIPMENT

Hollow Spindle Potentiometer

A triangular spindle potentiometer in which the spindle is formed from flat brass strip has been announced by the PLESSEY CO., LTD., Ilford, Essex. The design of the spindle eliminates the need for machining special flats and knob fixings, etc., all locations and fixings being achieved by bending or forming the hollow brass spindle to accommodate a polystyrene ring which, in turn, holds the brush gear. The limit stop and switch



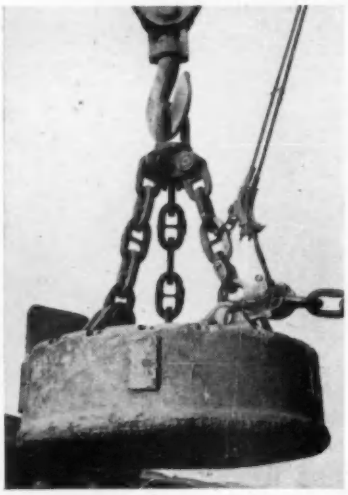
Plessey triangular spindle potentiometer

operating lug are also incorporated in the polystyrene ring. The control knob merely needs a triangular plain hole slightly smaller than the spindle size to give positive location in three alternative positions. The bush and back plate are a one-piece zinc-based die casting, which gives great rigidity and accuracy of location, and the use of polystyrene gives high insulation resistance.

Lifting Magnet

A range of circular lifting magnets for applications where the use is particularly rough has been announced by ELECTROMAGNETS, LTD., Boxmag Works, Bond Street, Birmingham, 19. The skirted outer poles form part of

Electromagnets lifting magnet



the outer shell for additional strength and the inner poles are of deep heavy construction. Both poles are spigoted and fitted with seals at the joint of the magnet shell to prevent the ingress of moisture. Lifting lugs and a terminal box are cast integrally with the magnet shell, which provides sufficient radiating surfaces to dissipate the heat generated by the windings. The terminal box is a double entry type fitted with an armour plate cover. Entry is through two compression glands for single core cables. There are four pancake windings of "chevron" section high conductivity copper strip with fireproof asbestos tape between turns. Each pancake is wound on a solid gunmetal support ring and assembled on a silicone impregnated resilient insulated metal former with silicone impregnated resilient insulation between pancakes. The coil is impregnated with silicone insulation varnish and encapsulated, the whole conforming to B.S. Class "H" specification and capable of withstanding severe shock treatment. Three sizes are available, having 57, 62 and 67in diameters, lifting 9,000, 11,500 and 15,600 lb respectively.

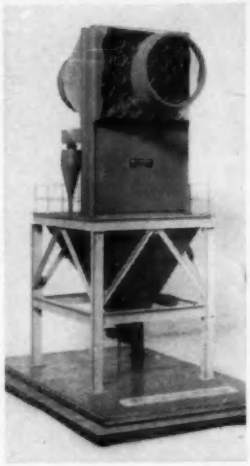
Rubber Conduit

A flexible rubber conduit strip which protects temporary leads, or wiring crossing floors, has been announced by VULCASCOT (GREAT BRITAIN), LTD., 87-89, Abbey Road, London, N.W.8. A ribbed non-slip face holds the conduit firmly to the floor and the double wedge cross section protects the leads, prevents tripping and allows trolleys and light trucks to be safely driven over the wiring. The conduit, which has a cable tunnel $\frac{5}{16}$in wide by $\frac{5}{16}$in high, is available in lengths up to 30ft and has a retail price of 3s 9d per foot.

Dust Collectors

The "Ludgate" multi-cell dust collector has been developed by the STURTEVANT ENGINEERING CO., LTD., Southern House, Cannon Street, London, E.C.4, to provide high collecting efficiency with a varying load, low resistance to gas flow, and long life coupled with little or no maintenance. The collector comprises a primary and a secondary circuit, the primary consisting of a bank of horizontal straight flow cells and the secondary of a high-efficiency vertical cyclone, arranged adjacent to the primary collector. Each primary cell is fitted with fixed guide vanes to impart an intense swirl to the entering gas, the dust being thrown centrifugally to the cell wall while the cleaned gas passes out through the outlet tube at the rear of the cell. The dust, with a small proportion of gas, is bled off through an annular slot situated between the end of the cell and the outlet tube. The heavier particles settle into the primary hopper leaving the gas-borne finer fraction to be separated in the secondary cyclone.

The "Newgate" grit collector also announced for shell type boilers is a centrifugal skimmer type appliance incorporating a device which enables the collecting efficiency to be maintained over a wide range of boiler load. The induced draught fan included with the collector is of the forward curved blade type designed for heavy duty. The primary collector scroll and the fan scroll may be swung through their axes to suit special requirements for inlet and discharge, and the secondary collector may be raised or lowered in relation to the primary scroll and cyclone booster

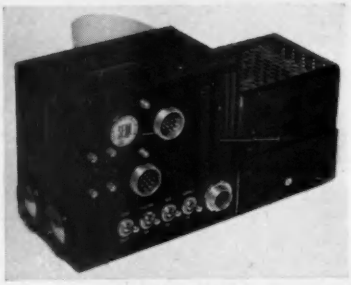


Sturtevant "Ludgate" dust collector

trunk, or extended sideways, to suit the particular plant and site requirements for the placing of the dust storage hopper, which provides approximately eight hours' storage capacity at full load. The additional resistance imposed on the system by the dust collector requires an approximate increase of 20 per cent in i.d. fan power.

Miniature Recorder

A miniature recorder, in which no record development is required, has been produced by S.F.I.M. (GREAT BRITAIN), LTD., 218-221, Bedford Avenue, Slough, Bucks. By using a high pressure mercury vapour lamp and special recording paper, the record is visible a few seconds after it is made. The recorder measures only 4·2 by 5·8 by 11·3in and weighs less than 10 lb. It is a self-contained unit requiring only an external power supply of 50 V d.c. Up to six continuously varying and two discontinuous parameters may be recorded



S.F.I.M. recorder

against a 1 sec time base. Twenty feet of 60 mm wide recorder paper can be accommodate in the recorder itself, and an external clip-on cassette can contain a complete 100ft roll.

At present three types are available, having speeds of 1 and 5 mm/sec, 5 and 25 mm/sec, and 100 mm/sec, giving recording durations up to 8 hr 20 min using the cassette. Each of the recording elements is provided with a mirror, or series of mirrors, displaced under the influence of the quantity being measured, and a spot of light traverses the length of the recording aperture for the full scale range of the element. The traces may cross one another and thereby achieve full deflection across the recording paper. Pressures and accelerations can be measured directly with special elements without having first to translate the quantity into electrical parameters.

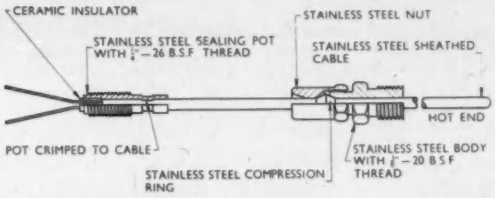
Power packs operating from 200 to 240 V 50 c/s or 115 V 400 c/s supplies are available. The power consumption of the recorder is 250 W.

Mineral Insulated Thermocouples

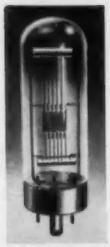
Thermocouples consisting of two dissimilar thermo-electric conductors, welded together at a point (the hot junction), embedded in highly compressed magnesium oxide insulant, and completely encased in a seamless, circular, stainless steel sheath, are now being produced by BRITISH INSULATED CALLENDER'S CABLES, LTD., 21, Bloomsbury Street, London, W.C.1.

The positive conductor is of nickel-chromium alloy and the negative conductor of nickel-aluminium alloy. The thermocouples are available in standard overall diameter sizes of 0·122in and 0·060in, with intermediate sizes if required, and corresponding conductor diameters of 0·020 and 0·010in. Units are available in lengths up to 100 yd, and the minimum insulation resistance is 100 MΩ per unit.

In the standard "hot" junction the conductors are welded together, and the sheath is welded over to form a hermetic seal completely insulated from the conductors, but without increasing the overall diameter of the cable. At the "cold end," a seal is fitted to prevent the insulant from absorbing moisture. The seal body is externally threaded to facilitate plain hole entry into junction boxes and instrument casings where it can be held in place by locknuts. The cold end assembly will operate at temperatures up to 150 deg C. Alternative arrangements at hot and cold ends can be made on request. These thermocouples give rapid thermal response since the small volume and high density of insulant offers excellent conductivity. By laying up mineral-insulated stainless steel sheathed thermocouples with stainless steel strands, a multiple flexible thermocouple of small overall diameter and high tensile strength has been produced.


CERAMIC INSULATOR
STAINLESS STEEL NUT
STAINLESS STEEL SEALING POT WITH ⅜"—26 B.S.F THREAD
STAINLESS STEEL SHEATHED CABLE
HOT END
POT CRIMPED TO CABLE
STAINLESS STEEL BODY WITH ⅜"—20 B.S.F THREAD
STAINLESS STEEL COMPRESSION RING

Sectional view of B.I.C.C. thermocouple and gland



"Osram" pin-base projector lamp

Projector Lamps

Three new "Osram" projector lamps have been announced by the GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2. Two of the new lamps show the current trend in projector lamps for 8 mm equipment in which the use of a low voltage filament enables light from the lamp to be concentrated in a small gate area. An 8 V, 50 W lamp for 8 mm ciné projectors has special silvered contours, the reflecting surfaces giving a sharply focused concentration of light on the film gate. When using the lamp, a screen brightness equivalent to that secured normally with high voltage 500 W lamps can be achieved.

In the 12 V 100 W projector lamp the filament is coiled on a rectangular mandrel, and this gives a considerable increase in the projected area of the filament along the backing mirror/lens axis and a large proportion of the total light output of the lamp is concentrated in this direction.

The third new lamp, for use with 35 mm slide projectors, embodies a pressed glass base into which four pins are sealed. The pins carry the filament assembly, which is accurately positioned during manufacture. This pin-base lamp is initially available in 300 and 500 W ratings.

Wide-Angle TV Tube Production

In the production of 110 deg cathode ray tubes by Cathodeon Electronic, Ltd., an important stage is the deposition of phosphor material forming the screen itself, on which the quality of the final picture to a great extent depends. After assembling the glass envelope from three separate sections, by fusing and annealing, the bulbs are made chemically clean and partly filled with a solution of barium acetate, to which the fluorescent material, activated zinc sulphide in suspension in potassium silicate, is added. This settles uniformly on to the glass face and adhesion is obtained by a gelling action.

Wide angle bulbs have to be almost completely filled to ensure satisfactory deposition on the curved screen area and, before the liquid can be removed by slowly tilting the bulb, enough must be extracted to prevent any disturbance in the narrow neck, which would damage the deposit. For this intermittent operation a Megator pump has been installed, with the suction hose mounted in a harness controlling the immersion level. The type R.8 pump, which has a capacity of 25 litres per minute, operates continuously, even with the suction line being constantly taken out of the liquid.

After drying, the screen deposit is covered by an aluminium backing which increases the picture brightness and reduces the risk of discoloration in service. The electron gun, also made in the Cathodeon factory, is then fitted, and the tube evacuated to a pressure of 10^{-6} mm Hg or lower. Adsorbed gases are removed by baking, the cathode activated by raising the temperature of the heater, and the tube is finally tested.

Removing liquid from 110 deg tubes

Financial Section

STOCKS and SHARES

OF the many companies which have now published their accounts and declared their dividends for 1958, it can be said that the majority have given some cause for satisfaction to the shareholders concerned. In a number of cases the financial results from last year's trading bear the marks, of course, of the credit squeeze and of its effect upon industrial activity; and the continued pressure on profit margins has been evident in one company report after another through references to a disproportionately small change in profits as the result of a company's successful efforts to increase output and sales. On the whole, however, the earnings so far reported have compared reasonably well with those of 1957, particularly in the case of those companies which had for a few months the benefit of last autumn's purchase tax and hire-purchase relaxations.

Earnings and Dividends

In the following table there are comparisons between the earnings of a variety of electrical and allied companies in the past two years, and a note of the rate of dividend paid for 1958:—

	Earned % 1957	Earned % 1958	Paid %
Aberdare	35	39	17½
A.E.I.	22	20	15
A. F. Bulgin	84	102	50
Bulpitts	—	43	15
Desoutter	65	68	21·6 (a)
English Electric ...	28	29	14
Ericsson	26	20 (b)	13 (b)
Hoover	127	162	60
Intl. Combustion ...	76	83	30 (a)
Laurence Scott ...	61	56	15
M.E.M.	28	28	10
Newman Ind.	18	20	10
C. A. Parsons... ...	40	34	8½ (a)
A. Reyrolle	51	51	17½
Switchgear & Cowans	18	29	15
Taylor Tunnicliff ...	51	61	17½
T.C.C.	38	54	25
Watford Elec. ...	50	66	25
Wolf Elec.	34	23	10

(a) Includes special interim dividends. (b) Tax free.

In these figures, adjustments have been made for scrip issues (but not for "rights" issues) distributed over the period. The earnings are based on net profits available for ordinary dividends after tax and all prior charges, and are expressed as a gross percentage on the nominal capital. The last two columns show the "cover" existing for present rates of dividend.

Dividend Policy

Dividends declared up to date this year have continued to reflect conservative policies in dealing with the profits of 1958, but in a number of cases boards of directors have permitted themselves a little more liberality than before. Partly no doubt this would be due to the easing of the credit restrictions, which formerly dictated exceptionally strict conservation of liquid resources, and it might be ascribed also to a growth of confidence in this year's business prospects as a result of tax reliefs and the Government's other encouragements to expansion. More than half the dividends entered in the foregoing table were at a rate higher than the previous year's.

Present Yields

Despite the tendency towards more liberality in this year's dividend declarations, the rise in share prices has reduced yields on leading industrial shares to an average of not much over 5 per cent, and to considerably lower returns than that in the case of the most popular shares and accredited "growth" stocks. In the electrical section, returns of a little either side of the 5 per cent mark have been shown lately, for example, by the shares of A.E.I., Ericsson Telephones, Chloride Electrical Storage and Electric Construction. Rather higher rates have been available, for instance, from Hackbridge Holdings, Hackbridge & Hewittic, Aerialite and Crabtree Electrical. In the lower ranges such shares as Crompton Parkinson, English Electric, Hoover, Lancashire Dynamo and Pye have recently been quoted on a yield basis of between 4 and 4½ per cent. C. A. Parsons and Plessey have been showing 3½ per cent or less, and Elliott-Automation and International Computers a fraction either side of 2 per cent.

Good Results

The Ever Ready (Great Britain) Company's announcement of an increase of more than 25 per cent in group trading profits for the year ended last February carries on a record of expansion uninterrupted for a decade or more. With the net surplus up to just over £1¼ million, after tax, shareholders are to receive their third successive increase in the dividend (in effect), from 20 to 27½ per cent, of which 7½ per cent takes the form of a special interim. In addition, a two-for-three scrip issue is proposed. (There was a 100 per cent share distribution less than two years ago.) These announcements evoked a sharp response from the shares, which were marked up initially from 28s to 33s 6d. They show a yield of about 4½ per cent on the new rate of dividend. Shareholders of British Thermostat received similarly good news in the company's announcement of substantially improved earnings, an increase in the distribution from 30 to 35 per cent and the proposal of a 100 per cent scrip issue. After moving up further from 47s to 51s 3d, the 5s shares offered a yield of 3½ per cent. Bowthorpe Holdings 5s shares were quoted a few pence lower, at 15s, after the appearance of the results: group profits were not greatly changed in 1958, but a 2 per cent interim payment is being added to the 25 per cent dividend and here again a scrip issue, in the ratio two-for-three, is proposed.

Bulpitts Outlook

Record results were achieved last year by Bulpitts, makers of "Swan Brand" electric kettles and other appliances, and in his statement accompanying the annual report the chairman described further prospects as highly satisfactory. At 15s 6d, the 5s shares are worth more than double the price at which they were publicly offered for sale in March of last year. Trading profits for 1958 came out substantially above the figures estimated at that time in the prospectus, and the dividend of 15 per cent is also above the rate then forecast. In the year now running, turnover was said at the recent annual meeting to have risen well above last year's corresponding level, and the purchase tax concessions were welcomed. The shares offer a yield of a little over 4¼ per cent on a dividend covered nearly three times over by earnings.

Preference Shares

Yields of around 6 per cent obtainable at the present level of prices from first-rate preference shares maintain a fairly good demand for investments of this character. Issues recently on offer in fair numbers included G.E.C. 6½ per cent "A" preference shares at 21s, and the same company's 4½ per cent "C" preference at 14s, the yield in both cases being a fraction over 6 per cent. Similar returns are shown on A.E.I. "eights" at 26s 3d, Atlas Electric "fives" at 16s 3d, E. K. Cole 5½ per cents at 17s and Hackbridge Holdings 5 per cents at 15s 9d. Others available to give a little under 6 per cent on the money include the 7 per cent preference shares of Ferranti and Automatic Telephone, both at 23s 9d, B.I.C.C. "sixes" at 20s 6d and Hoover 5½ per cents at 18s 9d.

Unit Trusts

A recent "block" offer of one million new units of Electrical & Industrial Development Trust called attention to the growth in the popularity of unit trusts among those who like their investments to be based on a very wide spread of interests. Some 119 companies are included at present in the portfolio of this trust and about 16 per cent of the fund is in companies known to be interested in developing the peaceful uses of atomic power. The units have been available lately at about 19s 9d to yield 5½ per cent on the present rate of dividend.

Our share list, which is not published owing to the Whitsun holiday, will appear again as usual next week

REPORTS and DIVIDENDS

Automatic Telephone & Electric Co., Ltd.—The main figures in the accounts for 1958 were given in our last issue.

In his statement, which has been circulated to stockholders, Sir Thomas Eades (chairman) says that although there was some diminution in the sales turnover of the parent company, the turnover for the group as a whole was comparable with that of the previous year. Efforts in the export field have been consistently maintained. Their main customer at home is the Post Office, whose expenditure programmes for 1958 and 1959 were reduced as part of the Government plan to restrict expenditure in nationalised undertakings. That the Government now considers the economy is ripe for expansion will be universally welcomed and it is hoped that it will provide additional capital for telephone development. While there is no immediate sign of the world economic situation completely recovering, looking ahead there are hopeful signs of gradual trade improvement.

Turning to research, Sir Thomas says they have spent about £500,000 during the year on this work. The Postmaster General has entrusted to them the development of special equipment which will enable subscribers in the London area and several of the largest telephone areas in the country to dial their own trunk calls. With the Post Office they are preparing designs for both electro-mechanical and electronic equipments, both types of which are now under test in the Post Office laboratories. They are devoting a considerable part of their research and development effort, in conjunction with the Post Office and the four principal telephone equipment manufacturers in the country, to the development of a fully electronic exchange (Highgate Wood). This is a long-term development, and many technical and economic problems are being solved.

On the transmission side, the Post Office has commissioned them to equip the Cardiff/Bristol coaxial cable with a 12·5 Mc/s system. It will be capable of providing 2,700 telephone channels on one pair of conductors. Another interesting development is the transistorised repeater which, enclosed in a rugged steel case, can be buried in the ground with the cable. During the year they installed buried repeaters on trial on a Post Office coaxial cable pair between Slough and Reading. Also in 1958 they completed the basic design of a completely new range of transistorised carrier terminal equipment. Associated Transistors, Ltd., the newly formed company in which they have an equal interest with the English Electric Co., Ltd., and Ericsson Telephones, Ltd., will shortly be in production of a range of transistors primarily to meet their telecommunications requirements.

Sir Thomas concludes his review with brief references to the progress of the subsidiary companies at home and overseas.

Pulsometer Engineering Co., Ltd.—Mr. F. B. Duncan (chairman) presided at the annual meeting held on 12th May. In his circulated review of the past year, the chairman said that the drop in profit was mainly attributable to two factors. First, the world recession in the requirements of the oil industry, the recession in the aircraft industry in this country and the general drop in mining requirements. Second, they had embarked on measures of replanning and modernisation and this had involved additional expenditure, a material part of which was reflected in the increased charge for depreciation.

Referring to the reorganisation of personnel, the chairman said that some part of this was already in operation and orders received by the group during the first quarter of 1959 showed a considerable increase over the corresponding period of last year. They had made new contacts and succeeded in negotiations for new business in the oil industry in Canada and America, and there was every prospect of an increasing Canadian market for the other products of the group, particularly in the hydraulic field.

G. & J. Weir Holdings, Ltd.—The annual meeting will be held on 3rd June. In his circulated statement, the Hon. J. Kenneth Weir (chairman) says that the group has had a good year's trading which has resulted in an improvement in earnings compared with 1957. Referring to the activities of the various companies in the group, the chairman says that the output of G. & J. Weir, Ltd., exceeded the previous year's performance by a substantial margin. Orders for new work both at home and abroad, however, were disappointingly low. The sharp decline in export orders reflected not only the small amount of work available, but also the emergence of strong local competition in Holland and West Germany. Nevertheless some good contracts were secured on the land side of the business. Orders were received for boiler feed pump sets from the C.E.G.B. for the Aberthaw and Belvedere stations and for two condensing and feed heating plants for the new station at Richborough.

Development work continued at a high level of activity. As a result of extensive tests during the year a new type of high speed turbo-driven feed pump has been introduced as well as a new and novel design of air compressor. Other developments relating to evaporating plants also reached the commercial stage. At the Cathcart works the department in which all rotary units are now manufactured was completed and the new Test Department brought into operation. The Repair Department has also been extended.

Output by Drysdale & Co., Ltd., at Yoker was well maintained and both marine and land sides made satisfactory contributions to the result. In line with developments in the field of power station generation, the demand has been for circulating pumps of ever-increasing capacity. During the year an order was received for six pumps of 72in diameter for Hinkley Point power station, and this will be the largest size that has ever been manufactured at Yoker. The order book is in a position to ensure that, subject to unforeseen contingencies, the year 1959 should make a satisfactory showing. Regarding Wm. Simons & Co., Ltd., the two diesel-electric paddle tugs for the Admiralty were launched, completed and delivered during the year.

Enfield Cables, Ltd.—With the report and accounts for 1958, the directors have issued a circular to shareholders setting out in detail the offer of Enfield Rolling Mills, Ltd., for the purchase of the whole of the issued capital of Enfield Cables. This offer was reported in our issue of 24th April, and the directors of Enfield Cables recommend acceptance in respect of each class of share capital and propose to accept the offers in respect of the preference shares and ordinary stock of the company which they themselves own.

The accounts for 1958 show a consolidated trading profit of £105,655, as compared with £162,885 for 1957, and after meeting all charges, including £16,884 for taxation, the net balance is £16,588 (against £60,150). As we have already reported, it is not proposed to pay an ordinary dividend for the year (against 2½ per cent).

In his accompanying statement, Mr. H. J. Randall (chairman) says that the year 1958 was a most unstable period for the cable-making industry as a whole, presenting difficulties to the company not the least of which was a contraction in the volume of business, particularly in the export market. In addition they had to suffer the delay in completion of the extension to the cable factory. The lower volume of cable business has been reflected in the work of the Contracts Department, which suffered a greater loss than in 1957. The reduction of telephone cable business, mentioned last year, has been more pronounced than before and the profit in 1958 was negligible. With one exception, the overseas subsidiary companies made profits in 1958, but these were slightly lower than for the previous year. The new Australian cable-making company, in which they hold a minority interest, has not yet achieved an economic level of production and the shareholders have agreed to merge its cable-making interests with that of its

chief competitor in a new company. Enfield Cables will, as a result, have interests in two Australian companies, one a cable-making company and the other a covered conductors business.

The outstanding event of 1958 was the completion and bringing into use of the high voltage laboratory which was formally opened last July by Sir Henry Self, chairman of the Electricity Council. The extension to the paper cable factory was not completed until the second half of 1958 and the installation of the new plant and equipment was delayed because of the failure of the plant manufacturers to meet delivery dates. It was not therefore until the end of the year that the company was equipped to make flat pressure and oil-filled cables and it was not able to bring these types of cables into commercial production until April this year; but in future this branch of their work should play an important part in the activities at Brimsdown. The new boiler house was completed during the summer and has more than justified its provision. Much effort has been devoted to the reduction of manufacturing costs, but most of these reductions will be apparent only if there is a higher load on the factory.

In spite of the lower overall volume of business, particularly in rubber insulated cables, they secured a number of important orders. These included the largest single order ever placed by the C.E.G.B. for 275 kV underground cable, and was for the supply and installation of six circuits each some 750 yd long of pipeline gas compression cable at Hinkley Point nuclear power station. A further notable contract carried out in 1958 was for the supply and installation of a 132 kV pipeline gas compression cable at Birmingham for the C.E.G.B. A similar contract at Liverpool for the same type of cable, valued at over £300,000, is being executed at the present time. High voltage copper connections are being supplied for the Bradwell nuclear power station. The factory at Tottenham, which produces cable accessories and light engineering work, had a record year. To further this side of the business they acquired the share capital of the English Salvi Co., Ltd., which acts as a selling agency for Salvi overhead line fittings manufactured at the Tottenham factory. These fittings have been supplied for the 900-mile overhead line which takes the power from the Kariba Dam project in Southern Rhodesia to the Copperbelt area in Northern Rhodesia, and to the C.E.G.B. for the 275 kV supergrid crossings of the Rivers Severn, Wye and Usk and other projects.

Bulpitts (Swan Brand), Ltd., held its annual meeting on 12th May, Commander the Hon. J. M. FitzRoy Newdegate presiding. In his statement, which had been previously circulated, the chairman said that the acquisition of Bulpitt & Sons, Ltd., and its subsidiaries took place on 26th March, 1958, and consequently the proportion of the profit for the year to 31st December last earned before that date was not available for distribution. The group had had a successful trading result. The profits were substantially in excess of those forecast in March last year, when the shares of the company were marketed, and were the highest ever achieved by the group. The price of copper was very low, the demand for their products was at a high level, and they were able to increase production steadily throughout the year. Their export trade had suffered from the continual imposition of trade barriers, particularly quota restrictions, which often were especially severe on household appliances. The extensions to their factory were occupied during 1958 and they now had under consideration plans for further extensions. The overall turnover this year to date was considerably higher than in the corresponding period of 1958.

Bowthorpe Holdings, Ltd.—Group net profits for 1958, after providing £349,370 for taxation, amount to £379,256, as compared with £373,083 for 1957. It is proposed to pay a final dividend of 18 per cent, making 25 per cent for the year (unchanged), and in addition to pay an interim dividend of 2 per cent on account of the current year. A two-for-three scrip issue is proposed, also the redemption of the 6 per cent cumulative preference £1 shares at 21s 6d each on 30th September next.

The Ever Ready Co. (Great Britain), Ltd., reports group profits for the year ended 28th February last of £2,430,553, as compared with £1,912,303 for the preceding year. Taxation absorbs £1,167,697 and the net balance is £1,262,856 (against £920,099). It is proposed to pay a final dividend of 15 per cent, and a special interim dividend of 7½ per cent in respect of the current year, making, with the previous interim payment of 5 per cent, a total of 27½ per cent. For 1957-58 the total was 20 per cent. It is proposed to increase the authorised capital from £5 million to £7·5 million and to make a two-for-three scrip issue.

G. N. Haden & Sons, Ltd.—The group profit for 1958, before taxation of £268,176, is £536,862, as compared with £421,543 for 1957. It is proposed to pay a dividend for the year of 25 per cent (against 17½ per cent), and to make a three-for-four scrip issue. The 1957 dividend included a 2½ per cent bonus.

John I. Thornycroft & Co., Ltd., have decided not to pay an interim dividend on the ordinary shares in respect of the year to 31st July next. The interim dividend in 1957-58 was 3½ per cent.

The British Thermostat Co., Ltd., reports that after providing £429,949 for taxation, the group net profit for the year ended 31st January last is £441,160, as compared with £387,433 for the preceding year. It is proposed to pay a final dividend of 22½ per cent (against 17½ per cent) and a bonus of 5 per cent (same), making 35 per cent for the year (against 30 per cent). A one-for-one scrip issue is also proposed.

The Engineering & Lighting Equipment Co., Ltd., reports that after providing £57,045 for taxation, the net profit for the year to 31st March last is £58,805, as compared with £27,700 for 1957-58. It is proposed to pay a final dividend of 15 per cent (against 10 per cent), making 20 per cent (15 per cent) for the year.

Mavor & Coulson, Ltd.—The annual meeting was held on 14th May. The report of the directors for 1958 stated that the turnover for the year was again higher than in the previous year. Profits were slightly higher but the rate of profit was reduced in the latter half of the year. The extension at Bridgeton was now in an advanced stage. Orders booked in 1958 showed a considerable decrease on those booked in 1957, and the value of orders on hand now was much lower than twelve months ago. This was due to the policy of retrenchment by the National Coal Board, their largest customer. Turnover was likely to drop this year and this with extra costs would adversely affect profits for 1959.

S. Smith & Sons (England), Ltd., are paying an interim dividend of 4½ per cent (against 3½ per cent).

Holophane, Ltd., has declared an interim dividend of 6 per cent (unchanged).

Burco Dean, Ltd., has announced an interim dividend of 6 per cent (against 5 per cent).

Bankruptcies

D. R. Kemp, formerly carrying on business at 15, Farnsworth Avenue, Ashton-under-Lyne, Lancs., and at North Mill, Katherine Street, Ashton-under-Lyne, under the style of Batty & Jackson, electrical contractors.—Receiving order made 5th May on debtor's own petition.

P. R. Gliddon and **M. E. Gliddon,** trading as Star Products, domestic electrical specialists, both residing and lately carrying on business at 59, Highland Road, Southsea, Portsmouth.—Receiving order made 6th May on debtor's own petition.

S. A. J. Ashford, formerly carrying on business at 45, Lower Oxford Street, Swansea, and previously at 69, Lower Oxford Street, Swansea, electrical and domestic appliance dealer.—Receiving order made 4th May on debtor's own petition. Public examination 9th July at the Law Courts, Guildhall, Swansea.

P. S. Brackenbury, lately carrying on business at 35, South End Road, Hampstead, London, N.W.3, gramophone, radio and electrical engineer.—Last day for receiving proofs for dividend 25th May. Trustee, Mr. G. F. Morris, Bankruptcy Buildings, Carey Street, London, W.C.2, Senior Official Receiver.

R. R. S. Richards, 4, Mount Street, Wrexham, Denbighshire, electrical and radio engineer.—Public examination 25th June at the Court House, Police Buildings, Wrexham.

Liquidation

Helikon, Ltd.—Particulars of claims by 30th June to the liquidator, Mr. P. A. L. Freeman, 8, The Spinney, Stanmore, Middx.

NEW PATENTS Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 6d each including postage) are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2

1954

25622. N.S.F., Ltd.—Electric switches of the toggle action type. 5th December, 1955. (813628.)

27197. Howard, R., and Cochrane, G. P. M.—Intercommunication systems. 20th September, 1955. (813682.)

1955

3344. English Electric Co., Ltd.—Gas-blast electric switchgear. 3rd February, 1956. (813683.)

13702. Heron, A. G.—Flexible electrically heated hoses. 14th May, 1956. (813505.)

17645. National Research Development Corporation.—Electric torque motors. 15th August, 1956. (813536.)

19305. Mervyn Sound & Vision Co., Ltd. —Electrical apparatus. 30th September, 1955. (814072.)

24778. Goldstaub, H. H.—Flexible electric heaters. 22nd November, 1956. (813508.)

26624. Goodmans Industries, Ltd.—Vibration generating motors. 10th December, 1956. (813745.)

35617. Chicago Telephone Supply Corporation.—Radio and television components with a plug-in mounting. 12th December, 1955. (813575.)

36216. British Broadcasting Corporation.—Compression of television signals. 6th December, 1956. (813510.)

1956

1313. General Electric Co., Ltd., and Marlow, E. F.—Printed electric circuits. 12th April, 1957. (813693.)

4308. General Electric Co., Ltd.—Colour television receivers. 6th February, 1957. (813482.)

5830. VEB Grubenlampenwerke.—Miners' electric headlamp sets. 24th February, 1956. (813696.)

10647. Flexible Lamps, Ltd., Flewitt, G. L., and Johnson, B.—Electric lampholders. 31st May, 1957. (813751.)

10651. Standard Telephones & Cables, Ltd.—Intelligence storage equipment. 5th April, 1957. (813580.)

11117. McGee, J. D.—Electron image multiplier apparatus. 9th April, 1957. (813581.)

12097. Sorensen & Co., Inc.—Voltage regulators. 20th April, 1956. (813582.)

13890. Brown, Boveri & Cie. A.G.—Electrically heated tunnel kiln with a reducing gas atmosphere for part of the heating zone. 4th May, 1956. (813513.)

13907. General Electric Co., Ltd.—Elements for high rupturing capacity electrical fuses. 6th May, 1957. (813643.)

15169. United Kingdom Atomic Energy Authority.—Nuclear reactors. 7th May, 1957. (813723.)

16176. Bonneau, A.—Electric distribution boards. 24th May, 1956. (813544.)

18606/7. Philips Electrical Industries, Ltd.—Electroscopes for radiation detection. 17th June, 1957. (813615/6.)

18819. Diamond Alkali Co.—Carbon electrodes. 18th June, 1956. (813515.)

20007. Standard Telephones & Cables, Ltd.—Magnetic storage device. 28th June, 1956. (813754.)

20497. General Electric Co., Ltd.—Methods of forming a junction in a semiconductor. 2nd July, 1957. (813547.)

21801. Standard Telephones & Cables, Ltd.—Storing of electrical intelligence. 13th July, 1956. (813726.)

22967. Etablissements Merlin & Gerin.—Electric air break circuit-breakers having arc-extinction chambers. 25th July, 1956. (813533.)

22968. Etablissements Merlin & Gerin.—Electric circuit-breakers with magnetic blow-out devices. 25th July, 1956. (813534.)

26877. Gloster Aircraft Co., Ltd.—Differential pressure electric switches. 3rd September, 1957. (813553.)

28213. General Electric Co., Ltd.—Electric lighting fittings. 3rd September, 1957. (813648.)

28554. Telegraph Construction & Maintenance Co., Ltd.—Electric cables. 10th September, 1957. (813554.)

29763. General Electric Co., Ltd., and Jenkins, R. O.—Electric discharge devices. 30th September, 1957. (813608.)

29764. M-O Valve Co., Ltd., and Jenkins, R. O.—Thermionic valves. 30th September, 1957. (813609.)

29977. Westinghouse Electric International Co.—Electrical contact brushes. 2nd October, 1956. (Addition to 805176.) (813649.)

31523. Atomic Energy of Canada, Ltd.—Radiation intensity measuring apparatus. 16th October, 1956. (813491.)

31794. M-O Valve Co., Ltd.—Thermionic valves. 30th September, 1957. (813760.)

31833. Whitmarley Engineering Co., Ltd. —Electrically heated de-mister for windows and the like. 1st October, 1957. (813652.)

32991. Robo-Sonic Industries, Inc.—Telephone message recording and message repeat back systems. 29th October, 1956. (813653.)

32993. British Insulated Callender's Construction Co., Ltd., and British Insulated Callender's Cables, Ltd.—Electric insulators. 28th October, 1957. (Cognate application 29540, 19th September, 1957.) (813818.)

34819. Siemens Edison Swan, Ltd.—Temperature control means for magneto-strictive delay lines. 17th October, 1957. (813591.)

35590. Western Electric Co., Inc.—Semiconductor devices and circuits utilising them. 21st November, 1956. (813862.)

35606. British Thomson-Houston Co., Ltd.—High frequency electronic oscillators. 19th November, 1957. (813938.)

39018. Western Electric Co., Inc.—Line scanning systems. 21st December, 1956. (814081.) 39019. Electrical systems for scanning a plurality of devices. 21st December, 1956. (814082.)

39627. Eitel-McCullough, Inc.—Cavity resonator type electron tube apparatus. 31st December, 1956. (813711.)

1957

43. Compagnie Générale de Télégraphie sans Fil.—Oscillator circuit arrangements of the type incorporating a semiconductor junction diode. 1st January, 1957. (813943.)

245. Telefonaktiebolaget L. M. Ericsson.—Transistor amplifiers. 2nd January, 1957. (813944.)

1906. Okonite Co.—Apparatus for taping electrical conductors and the like. 18th January, 1957. (814111.)

2780. Standard Telephones & Cables, Ltd.—Electrical circuit for comparing two numbers. 25th January, 1957. (813768.)

4296. Dow Chemical Co.—Cathodic protection system and anode therefor. 7th February, 1957. (813657.)

4779. A.E.I. Hotpoint, Ltd.—Refrigerators. 12th February, 1958. (813713.)

5102. Metropolitan-Vickers Electrical Co., Ltd.—Removal of dust particles from gases. 11th February, 1958. (813594.)

6800. Sylvania Electric Products, Inc.—Coating electric lamp envelopes. 28th February, 1957. (813732.)

8657. Bessemer Securities Corporation, Hedges, J. D., and Balaguer, R. R.—Primary battery and production thereof. 15th March, 1957. (813800.)

12488. Robertshaw-Fulton Controls Co.—Anticipatory heater circuit for electric thermostat controls. 17th April, 1957. (813716.)

14917. Westinghouse Electric International Co.—Electric arc welding. 10th May, 1957. (813472.)

17781. Sylvania Electric Products, Inc.—Method of sealing glass envelopes of electrical devices containing gas at a pressure above atmospheric. 4th June, 1957. (813665.)

22213. United-Carr Fastener Corporation.—Shielding devices for electron discharge tubes or the like. 12th July, 1957. (813667.)

23415. Westinghouse Electric International Co.—Electric circuit-breakers. 24th July, 1957. (813734.)

25033. Coates, C., and Lardner, W. E.—Electric selective systems. 8th August, 1957. (813672.)

30399. Siemens & Halske A.G.—Delay networks incorporating diode amplifiers. 27th September, 1957. (813676.)

34159. General Electric Co.—Magnetic tape reading system. 1st November, 1957. (813720.)

39596. Allmanna Svenska Elektriska A.B. —Pressure relief arrangements for lightning arrestors. 20th December, 1957. (813680.)

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to the dates stated:—

6th June

No. 781,465 (design). Class 9. Electrical capacitors.—Dennison Developments, Ltd., 222, Soho Hill, Handsworth, Birmingham, 19.

Multimeg. No. 785,132. Class 9. Electric resistances for incorporation in electrical and electronic apparatus; and electrical and electronic apparatus incorporating such resistances.—Painton & Co., Ltd., Bembridge Drive, Kingsthorpe, Northampton.

Aetec. No. 787,019. Class 9. Thermo-electric pyrometers.—Negretti & Zambra, Ltd., 122, Regent Street, London, W.1.

Corru. No. 784,973. Class 11. Heating apparatus and heating materials, all being electric; lighting apparatus and appliances; guard devices for lighting and heating; electric lighting fittings; lamp hanging supports, lamps, lamp globes; vacuum tubes and vacuum bulbs, all for lighting purposes; ventilation apparatus, etc.—Wandleside Cable Works, Ltd., 106, Garratt Lane, Wandsworth, London, S.W.18.

Zenith. No. 763,632. Class 15. Electronic piano and electronic organs, and parts. —Zenith Radio Corporation, Chicago, Ill., U.S.A. Address for service, c/o Stevens, Langner, Parry & Rollinson, 5 to 9, Quality Court, Chancery Lane, London, W.C.2.

13th June

Brimar. No. 781,422. Class 9. Semiconducting crystal devices, being electrical goods.—Standard Telephones & Cables, Ltd., Connaught House, 63, Aldwych, London, W.C.2.

Altoflux. No. 786,593. Class 9. Flowmeters and parts and electrical alarm systems for use in connection therewith; and meters, and parts, for indicating the amount of solid matters held in suspension in liquids.—Alto Instruments (Great Britain), Ltd., Maxwell House, 11, Arundel Street, Strand, W.C.2.

Camplex. No. 772,152. Class 11. Heating apparatus; lighting apparatus for use in the growing of crops; and apparatus for sterilising soil.—Simplex Dairy Equipment Co., Ltd., Cintra House, 16, Hills Road, Cambridge.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses

Australia.—Brisbane City Council. 19th June. Overcurrent relays. (E.S.B. 10889/59. Ten/38928.)*

Metropolitan Water Sewerage and Drainage Board, Sydney. 28th July. Four electrically driven centrifugal pumping sets. (E.S.B. 10958/59. Ten/38930.)*

Director, Stores and Contracts, Postmaster General's Department, Melbourne. 9th July. Radio telephone equipment and spares. (E.S.B. 11715/59. Ten/39081.)*

Burma.—Burma Purchase Board, Rangoon. 2nd June. Lampshades, switches, electric lamps and conduit bands. (E.S.B. 11634/59. Ten/39061.)*

Formosa.—Taiwan Power Co. 1st June. One 970,000 lb/hr steam generating unit and one 140 MW turbine generator unit for Shen-Ao power station. (E.S.B. 11145/59/I.C.A. Ten/38956.)*

Central Trust of China, Taipei. 2nd June. Power supply equipment, including transformers ranging from 5 kVA to 200 kVA, insulators, aluminium steel reinforced cable and lightning arrestors. (E.S.B. 11013/59/I.C.A. Ten/38981.)*

Greece.—Ministry of National Defence, Athens. 5th June. Underground cable and loading coil boxes. (E.S.B. 11536/59. Ten/39015.)*

India.—Director General of Supplies and Disposals, New Delhi. 2nd June. Forty-nine battery charging metal rectifier units. (E.S.B. 11350/59. Ten/38974.)*

India Supply Mission. 23rd June. 66 kV switchgear extensions and metering equipment. (E.S.B. 10412/59/I.C.A. Ten/39100.)*

Madras Port Trust. Portable welding sets, universal milling machines and portable air compressor. (See this issue.)

Iraq.—Central Foreign Purchase Board. 7th June. Radio valves for the Directorate General of Civil Aviation. (E.S.B. 11747/59. Ten/39117.)*

Korea.—Government Office of Supply, Seoul. 3rd June. Substations and equipment. (E.S.B. 11166/59/I.C.A. Ten/38982.)*

New Zealand.—G.P.O., Wellington. 11th June. Potentiometers and resistors. (E.S.B. 11459/59. Ten/39008.)* 15th June. Coaxial cable. (E.S.B. 11458/59. Ten/39007.)*

Pakistan.—Director General, Department of Supply and Development, Karachi. 1st June. 106 multi-stage turbine or submersible type electrically driven pumps. (E.S.B. 11096/59/I.C.A. Ten/38957.)* 2nd June. Forty-four sets of deep well, electrically driven pumping sets. (E.S.B. 11250/59/I.C.A. Ten/38985.)*

Philippines.—National Power Corporation, Manila. 23rd June. 50,000 kVA power transformer. (E.S.B. 11642/59. Ten/39068.)*

Rhodesia and Nyasaland.—Bulawayo Electricity Department. 3rd June. Insulated single core cables and bare hard-drawn copper conductors. (E.S.B. 11523/59. Ten/39040.)* 1st July. Two 10,000 kVA transformers and voltage regulating equipment. (E.S.B. 11522/59. Ten/39017.)*

Sedgley.—U.D.C. 8th June. Street lighting equipment. (See this issue.)

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

South Africa.—Stores Department, South African Railways, Johannesburg. 29th May. Conduit tubing. (E.S.B. 11543/59. Ten/39073.)*

Union Tender Board, Pretoria. 5th June. Transmitters and receivers. (E.S.B. 11644/59. Ten/39069.)*

Uruguay.—Usinas Electricas del Estado, Montevideo. 9th June. Equipment for transformer stations and substations. (E.S.B. 10515/59. Ten/39001.)*

ORDERS PLACED

Consett (Durham).—U.D.C. Improved street lighting from Consett to Leadgate (£2,360).—A.E.I. Lamp & Lighting Co.

Durham.—County Council. Electrical installation in Ivy House Hostel, Sedgefield (£2,706).—North of England Engineering & Electrical Co.

Newcastle-on-Tyne. — City Council. Mercury arc rectifiers at Westgate substation (£26,980).—Hackbridge & Hewittic Co.

Regional Hospital Board. Electrical installation in operating theatre at Sunderland General Hospital (£7,955).—F. Reid Ferens & Co.

Southampton. — Corporation. Recommended. Renewal of the electrical installation at the College of Art and Deanery Secondary School (£9,761).—Dicks, Ltd.

Wallasey.—Corporation Education Committee. Recommended. Electrical installation at St. George's Secondary Modern School for Boys (£4,451).—J. & L. V. Walsh, Ltd.

Windsor.—Corporation. Electrical installations in 114 houses at the Smiths Lane site (£3,570).—Drabble Construction.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Birmingham.—Primary school, Ladywood estate; W. & J. Webb, Ltd., 257, Great King Street.

Felling (Co. Durham).—Community hall and shops, Carlisle Street; U.D.C. surveyor.

Gateshead.—Health centre, Wrekenton; G. F. Winters, borough engineer.

Shops, offices and covered market; Auto Body Services, Ltd., 67, West Street.

Glendale.—Houses (24), Wooler; A. R. Field, R.D.C. surveyor.

Gosforth.—Houses (42), Grange Lane estate; A. R. Robertson, Ltd., builders, East

Hartlepool.—Houses (85), near King Oswy Drive, North Eastern Housing Association, Ltd., Windsor Terrace, Newcastle-on-Tyne.

Haverhill.—Factory, Bumpstead Road; J. C. Myers, architect, 23, High Street.

Hebburn.—Houses (61), Toner Avenue; U.D.C. surveyor.

High Wycombe. — Works extensions; Harrison & Sons, Ltd., Hughenden Avenue.

Hornchurch.—Branch library and further education centre, Whybridge; H. Conolly, county architect, County Hall, Chelmsford.

Hull.—Adult occupation centre, Leeds Road; Gelder & Kitchen, architects, 120, Alfred Gelder Street, Hull.

Ince-in-Makerfield.—Five blocks of flats on old Central Schools site; surveyor, Town Hall, Ince, near Wigan.

Leicester.—Day nursery, Cossington Road (£20,000); city architect.

London.—Flats and maisonnettes (45), Alexis Street, Bermondsey; borough surveyor.

Police station, Highgate; Wm. Moss & Sons, Ltd., North Circular Road, N.W.2.

Extensions, National Heart Hospital, Westmoreland Street, Marylebone; Griggs & Sons, Ltd., 56, Victoria Street, S.W.1.

Flats (120), Studley Road, Lambeth; Wates, Ltd., 1258, London Road, S.W.16.

Houses (33), West Hill, Putney; A. Llewellyn Smith, architect, 103, Old Brompton Road, S.W.7.

Longbenton (Northumberland). — R.C. primary school; R. Burke, architect, 10, Lambton Road, Jesmond, Newcastle-on-Tyne.

Market Bosworth.—Houses (85); surveyor, Rural Council Offices, Market Bosworth, Leicestershire.

Maryport.—Houses (70); U.D.C. surveyor.

Merthyr Tydfil. — Operating theatre, General Hospital; E. Turner & Sons, Ltd., Penarth Road, Cardiff.

Middlesbrough.—R.C. church, Beechwood; S. Stevenson Jones, architect, Harley Buildings, Old Hall Street, Liverpool.

Milford Haven.—Grammar school, Steynton; county architect, County Offices, Haverfordwest.

Newcastle-on-Tyne.—Provision of extra office accommodation at the Central Station; British Railways, York.

Nottingham.—Six-storey office block, Station Street (£800,000) for Boots Pure Drug Co.; William Moss & Sons, Ltd., building contractors, Queen's Road, Loughborough.

Peterborough.—Houses (58), Gunthorpe estate; S. B. Fairchild & Son, Ltd., 11, Welland Road.

New hospital, Thorpe Road area; G. Aldis, Board's architect, East Anglian Regional Hospital Board, Cambridge.

Pitsea.—Community centre, secondary and primary schools, shops, etc., in connection with redevelopment scheme; general manager, Development Corporation, Gifford House, London Road, Bowers Gifford, Essex.

Plymouth.—Civic Centre offices; Hoare, Lea & Partners, electrical and heating consultants, 5, Headland Park.

Redditch.—Houses (50), Webheath estate; surveyor, The Council House.

Rhondda.—Houses (147), Maerdy; C. Gingell, borough housing architect, 13, Ystrad Road, Pentre, Rhondda.

Sheffield.—Operating theatre and dental department, Fulwood Royal Hospital; J. F. Finnegan & Co., Ltd., 847, Ecclesall Road.

Physics and mathematics departments for University; Tersons, Ltd., 4, Dollis Park, London, N.3.

South Shields.—Factory additions for S. Newman, Ltd.; J. Cummings, builder, Matamba Terrace, Sunderland.

Stockton-on-Tees.—Head Post Office, High Street; Ministry of Works, Lambeth Bridge House, London, S.E.1.

Thirsk.—Houses (26) for the R.D.C.; Needham, Thorpe & White, architects, 5, High Petergate, York.

Tynemouth.—Proposed housing developments providing for 629 houses at Marden North; J. T. Bell & Sons, builders, Market Street Chambers, Newcastle-on-Tyne.

Wenlock.—Civic hall and swimming baths, Broseley (£100,000); borough engineer, Ironbridge, Salop.

West Hartlepool.—Proposed College of Further Education; A. G. Sinclair, borough architect.

Wymondham. — Two hostel blocks, Wymondham College; E. J. Tofts, Ltd., builders, Attleborough.